TF 2401A

TF 2401A

Counter

INSTRUCTION MANUAL

MARCONI INSTRUMENTS LIMITED
ST. ALBANS HERTFORDSHIRE ENGLAND

Alternative Colour Coding
for Mains Leads
(Blue - Black - Green/Yellow series)

WARNING

The colour coding on mains leads is being changed to conform with international recommendations. During the change-over period, the instrument with which this manual is issued may be wired in either the old or new colours as follows:

	Old colour code	New colour code	Sleeve symbol
LINE (PHASE)	Blue	Brown	
NEUTRAL	Black	Blue	N
EARTH (GROUND)	Green/Yellow	Green/Yellow	⏚

Note particularly that BLUE is live in the old coding and neutral in the new coding.

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INSTRUCTION MANUAL
No. EB 2401A
for

Counter TF 2401A

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1966

MARCONI INSTRUMENTS LIMITED
ST. ALBANS HERTFORDSHIRE ENGLAND

C.P. 1c
10/70/G

EB 2401A
1d - 1/70

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General information

1.1 INTRODUCTION

The TF 2401A Counter is a general purpose instrument which achieves a wide range of facilities by having all input channels in the form of plug-in units. For most measurements two plug-in units are used - a Frequency Range unit, and a Function unit which determines the type of measurement being made.

Essentially the TF 2401A comprises a precision crystal oscillator, decade count-down time base, gating circuits, and a series of cascaded decade counting units (D. C. U. 's). Extensive use has been made of logic techniques; and semiconductors, printed circuitry and modular plug-in construction are used throughout.

Additional features include a display memory, measurement units illuminated in the display window and a stand-by facility which allows the oven power supply to be run so that the oven has sufficient time to stabilize without the necessity of energizing the rest of the counter. The instrument may be controlled by an external 1 Mc/s frequency standard.

A printer or remote readout may be driven by the counter, and as an optional facility the instrument may be adapted to accept control from a remote source.

The instrument can also be used as a time interval generator, providing pulses from 0.01 c/s to 1 Mc/s in decade steps. 1 Mc/s and 10 Mc/s outputs are also available on separate sockets.

Bench or rack-mounted versions of the instrument are available.

Further information concerning any plug-in unit will be found in the relevant manual.

Fig. 1.1 Counter with range and function units

1.2 DATA SUMMARY

DISPLAY : 8 digit in line, with memory.

DISPLAY TIME : Continuously variable from approximately 0.1 to 5 sec, or held indefinitely until manually reset.

TIME BASE : 10 μsec to 100 sec in decade steps, or selected manually.

READOUT

Frequency Measurements : Directly in c/s, kc/s, or Mc/s depending on the setting of the TIME BASE switch.

Period and Time Interval Measurements : Directly in sec, msec or μsec.

DECIMAL POINT : Automatically positioned for appropriate units.

ACCURACY : Dependent on standard frequency (Time Base reference), ±1 count.

Standard Frequency

Internal 16 Mc/s Oscillator

Stability : ±1 part in 10^9, short term; $+1 \times 10^{-7}$ per month, after 30 days aging and at constant temperature.

Adjustment : Provision is made to adjust the oscillator frequency.

External Standard: See '1 Mc/s CONNECTOR' below.

Rear panel connections

B.C.D. OUTPUT

Code : 1-2-4-8 Binary Coded Decimal.

Logical '0' : 0 V nominal.

Logical '1' : -4.5 V minimum.

Code Line Impedance : 3.9 kΩ nominal.

Print Command : Pulse, 0 to -5 V minimum; approximately 15 μsec in width, at no load, occurring at end of gate time.
Output impedance; 27 Ω approximately.

Inhibit : Applied contact closure between two pins on Printer connector.

TIME BASE OUTPUT CONNECTOR : 0.01 c/s to 100 kc/s in decade steps. Negative pulse, 0 to -4.5 V minimum. 1 Mc/s at 1 V p-p.
Output impedance; 10 kΩ approximately.

1 Mc/s CONNECTOR :	Accepts standard frequency input (sine wave or square wave), or delivers sine wave output depending on position of associated switch. Input : 2 V to 5 V r.m.s.; input impedance, >1 kΩ. Output : sinewave; 1.0 V r.m.s. minimum at a source impedance of < 200 Ω.
10 Mc/s CONNECTOR :	0.5 V r.m.s. minimum; source impedance, < 500 Ω.
POWER REQUIREMENTS :	Two ranges 100 V to 150 V and 200 V to 250 V in 10 V steps. 45 to 65 c/s. 120 W max.

DIMENSIONS :

Height	*Width*	*Depth*
5 3/4 in (15 cm)	17 in (43 cm)	$17\frac{1}{4}$ in (44 cm)

WEIGHT : Approximately 38 lb (17.2 kg).

1.3 ACCESSORIES

Supplied

Two coaxial free plugs; Type BNC.
Board extractor.

Available

TF 2402 : Digital to Analogue Converter.
Provides a current or voltage analogue of the counter output, to drive a pen recorder. Any three consecutive digits, or the last two are selected manually from a maximum of seven. A wide range of recorder input requirements can be accommodated.

TF 2403 : Digital Code Converter
Converts the 1-2-4-8 BCD output of the counter, to an alternative code suitable for a particular type of printer or other data handling equipment.

TF 2404 : Out of Limits Indicator
Monitors counter readings and compares them with two preset limits; visual and electrical indication is given of the relationship of the reading to the limits.

TF 2405 : Analogue of Difference Unit
Produces a voltage or current analogue of the difference between a counter reading and a manually set datum. This analogue output is positive or negative going according to whether the reading is above or below the datum; the polarity may be selected to give positive output for readings below and negative for those above the datum, or vice versa. Visual indication is given of whether readings are above or below the datum, output less than 10% of full scale, and range exceeded.

Extension board (set of three) twin sided, TM 7892.

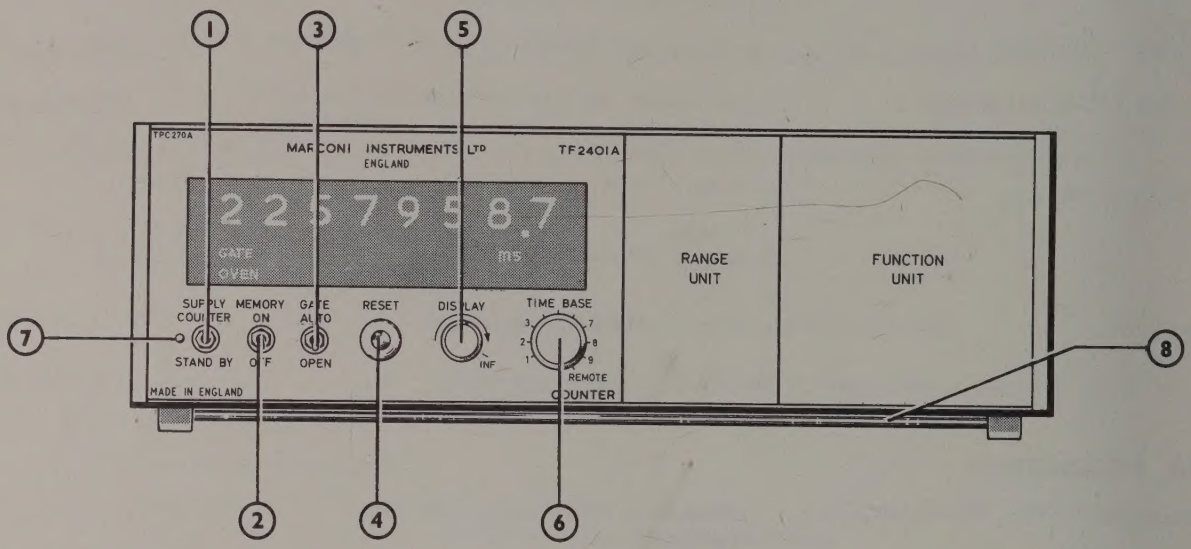
Extension board, single sided, TM 7893.

These boards facilitate servicing by holding the printed circuit boards clear of the instrument, giving easy access to all components and soldered joints on the board.

50 way Amphenol plug, type 57-30500. To mate with the PRINTER CONNECTOR when the Counter is used to drive a peripheral device.

Section 2

Operation



2.1 INSTALLATION

When fitting a plug to the mains lead, note that the earth (or chassis) conductor has a yellow designation sleeve with a green circuit earth symbol, the neutral conductor has a black sleeve with a white 'N' and the line (or phase) conductor has no sleeve.

Before connecting the instrument to the power supply, check that the transformer tapping and fuse rating are correct for the available supply voltage. The instrument is normally despatched for use with 230 V supplies but may be adjusted for other voltages as described in Section 5.4.

Once the instrument is switched on, the oscillator takes less than 90 seconds to reach a frequency which is within 4 parts in 10^7 of its final value.

The time taken to achieve ultimate aging rate depends upon the length of time the oven has been off. In the worst case, after long periods out of use, the oscillator will attain its final aging rate after a maximum of 20 days from switch on. When the instrument is switched on again after being off for 24 hours, the oscillator will take about 3 hours to regain the aging rate at switch off.

The instrument should be operated with the ventilation holes at the rear and underneath unobstructed.

2.2 RACK MOUNTING

Before installing the Counter, slides or runners should be fitted to the rack to support the instrument. The retaining screws should not be relied upon to take the weight of the Counter.

2.3 CONTROLS AND CONNECTORS

(1) SUPPLY switch. In the STANDBY position the supply is connected to the oven only.

(2) MEMORY switch. When set to OFF the DCU's cycle during counting and the counted number is displayed only during

the display time selected. When set to ON, the display is continuous.

③ GATE switch. In the AUTO position reset is automatic. In the OPEN position the gate is held open and controlled manually.

④ RESET button. Used to manually reset the DCU's and recycle the instrument.

⑤ DISPLAY control. Adjusts the display time from 0.1 sec to 5 sec approximately. INF setting holds display until RESET button is pressed.

⑥ TIME BASE switch. Selects the reference frequency. The frequency or time interval selected depends upon the TIME BASE switch position, and function selected by the Function unit. In the REMOTE position the switch is replaced by an external one; this facility is only available when the instrument is modified to allow remote control.

⑦ INDICATOR lamp. On when instrument is plugged into mains supply.

⑧ SUPPORT. Hinges downwards to raise front of instrument.

The following facilities are located on the rear panel.

EXTERNAL-INTERNAL switch and connector. With the switch in the INTERNAL position the instrument utilizes the internal oscillator and provides a 1 Mc/s output at the socket. With the switch in the EXTERNAL position the internal oscillator is disconnected and an external 1 Mc/s standard frequency must be applied to the connector.

10 Mc/s OUT connector. Provides a 10 Mc/s standard with the accuracy of the oscillator.

TIME BASE OUT connector. Provides an output from the time base section determined by the TIME BASE switch and the FUNCTION switch.

PRINTER connector. Provides the BCD output of the D. C. U. 's, command pulse, inhibit and earth to an external readout device.

FUSES. Two delay fuses. Both should be 1 A when 230 V supplies are used, and 2 A when 115 V supplies are used.

EARTH terminal.

2.4 EXTERNAL FREQUENCY STANDARD

Provision is made to allow control of the instrument with an externally applied frequency standard of 1 Mc/s sine wave or square wave.

When this facility is used, the external standard is plugged into the BNC socket provided (located on the rear panel), and the associated switch moved to the position marked EXTERNAL 1 Mc/s STD. IN.

NOTE : When applying an external standard, the switch must be in the EXTERNAL position.

2.5 CONNECTING A PRINTER

A 50 way Amphenol plug, type 57-30500 (with cover) must be fitted to any equipment that is to be driven by the Counter. This plug will mate with the PRINTER CONNECTOR on the rear of the instrument.

Socket pins in the PRINTER CONNECTOR provide binary coded decimal (BCD) outputs from the decade counting units. These outputs can be employed to feed a printer or a remote readout. The connector also carries command pulse output, inhibit input, decimal point, and earth sockets.

The sockets in the PRINTER CONNECTOR are numbered, and Table 2.1 shows the output or input that each of these sockets carries. The groups (of four) of binary coded outputs and the corresponding digits, are listed sequentially from the right-hand end of the eight-digit readout on the Counter.

2.6 OPERATING PROCEDURE

Refer to the appropriate Function manual for the operating procedure.

TABLE 2.1

Socket	Output (approximate)	Function
20 and 49	-6 V	
19	0 V or -6 V	D3) Decimal point; on
18	0 V or -6 V	D2) when at -6 V. (D1
17	0 V or -6 V	D1) on extreme right.)
50	Earth	
47	-6 V pulse	Print Command
48	(Input) -6 V	Inhibit
	0 V or -6 V representing	
1	'0' or '1'	
2	'0' or '2'	1st digit
26	'0' or '4'	(reading from right)
27	'0' or '8'	
3	'0' or '1'	
4	'0' or '2'	2nd digit
28	'0' or '4'	
29	'0' or '8'	
5	'0' or '1'	
6	'0' or '2'	3rd digit
30	'0' or '4'	
31	'0' or '8'	
7	'0' or '1'	
8	'0' or '2'	4th digit
32	'0' or '4'	
33	'0' or '8'	
9	'0' or '1'	
10	'0' or '2'	5th digit
34	'0' or '4'	
35	'0' or '8'	
11	'0' or '1'	
12	'0' or '2'	6th digit
36	'0' or '4'	
37	'0' or '8'	
13	'0' or '1'	
14	'0' or '2'	7th digit
38	'0' or '4'	
39	'0' or '8'	
15	'0' or '1'	
16	'0' or '2'	8th digit
40	'0' or '4'	
41	'0' or '8'	

NOTE

Accuracy of electronic counters

In general there will always be a possible error of ±1 count on the least significant digit. This, together with the discrimination required, will determine whether Frequency or Period measurement is used, see Fig. 2.1.

(1) Frequency Measurement. Accuracy is determined by the stability of the internal standard which provides the accurate counting interval. In addition there will be the ±1 count and thus for a given gate time higher frequencies will be displayed with the greatest discrimination and accuracy.

(2) Period Measurement. The errors in period measurement will be :- (a) Ambiguity of gate triggering level. (b) Accuracy of internal timing units. (c) The ±1 count.

For sine wave inputs the total possible error may be expressed as

$$\frac{1}{\pi} \times \frac{En}{Es}$$ where

En = total noise, including that due to counter circuitry,
Es = signal level,

or $\frac{1}{n\pi} \cdot \frac{En}{Es}$ where n is the number of periods in multi-period average measurements.

(3) Phase Measurement. The reference and out of phase signals are used to start and stop the counter, the latter being arranged for period measurement and time interval measurement.

$$\phi = 360^{o} \frac{t}{T}$$ where

ϕ = phase difference in degrees,
t = phase difference in counter timing units,
T = period of signal in counter timing units.

Thus if the counter is to read directly in degrees external timing units must be provided of a frequency n. 360 fs where n is an integer determining the discrimination desired and fs is the frequency of the signal to be measured. The accuracy obtained is a function of the ambiguity of the triggering level.

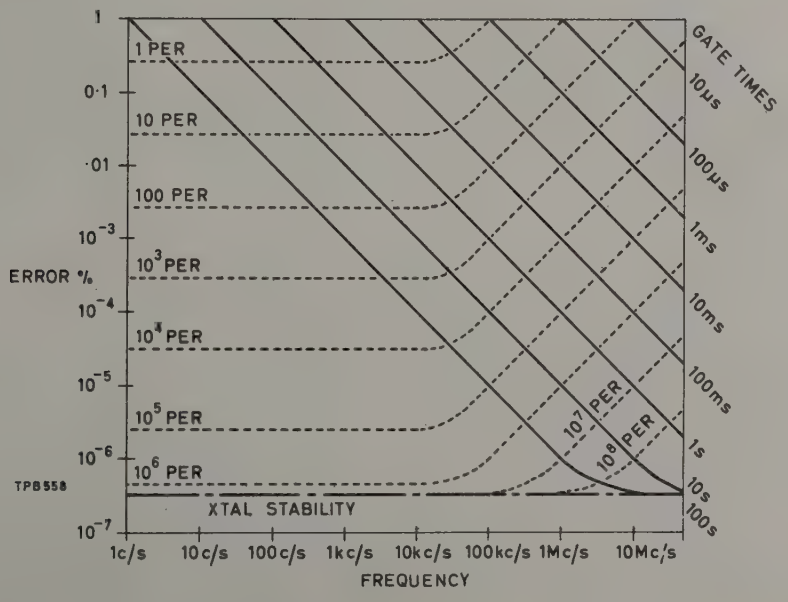


Fig. 2.1 Accuracy chart

Section 3

Logic description

3.1 INTRODUCTION TO COUNTER LOGIC

In general the two stable states of the switching circuits used in TF 2401A are approximately 0 V and -6 V. Negative logic is used; i.e., the -6 V state is the active condition of a signal.

The simplest forms of logic elements are diode AND and OR gates. Fig. 3.1 shows an AND gate, and it is seen that the output, D, is present when signals A and B and C are in the active state.

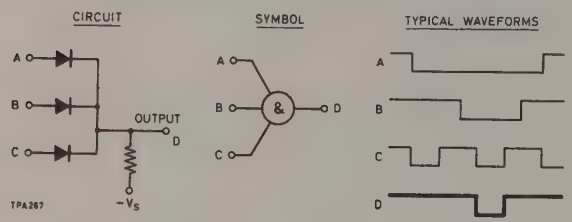


Fig. 3.1 AND gate (3 input)

For an OR gate, shown in Fig. 3.2, an output is produced for an A or B or C signal.

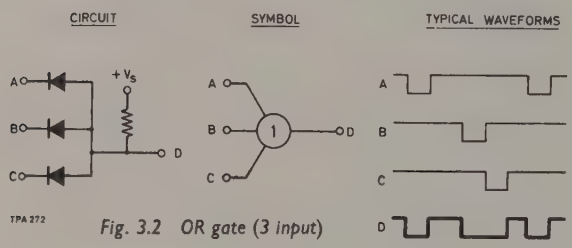


Fig. 3.2 OR gate (3 input)

For positive logic the above circuits are similar except that the supply voltages are of opposite polarity and the diodes are reversed :

An inhibit input may be applied to a gate to prevent the gate from giving an output when the inhibit input is in the active state. For a negated inhibit input, the gate is prevented from operating when the inhibit input is in the inactive state. Examples of these inputs in the Counter, are $\overline{S9}$ $\overline{S11}$ etc. Fig. 3.3 shows the symbols used for inhibit gates. An inhibit, or negated inhibit input may be applied to a multi-input AND or OR gate.

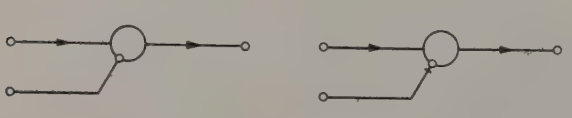


Fig. 3.3 Inhibit and negated inhibit gates

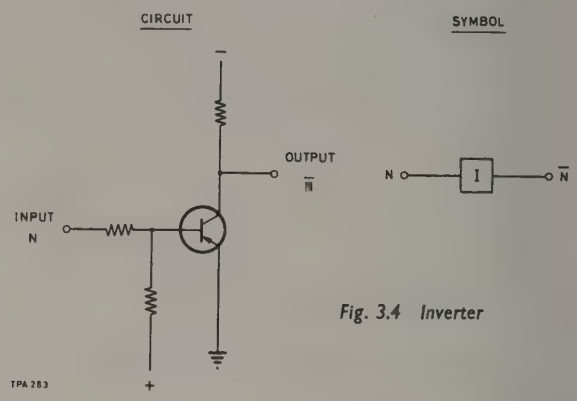


Fig. 3.4 Inverter

The inverter is a logic element which is used to invert a signal. A simple inverter is shown in Fig. 3.4. A signal 'N' applied to the input is delivered at the output as '$\overline{N}$' i.e., not N.

If an inverter has a number of inputs as shown in Fig. 3.5, it will function as a NOR gate, i.e., if any one of the inputs is in the active state, the output will be inactive.

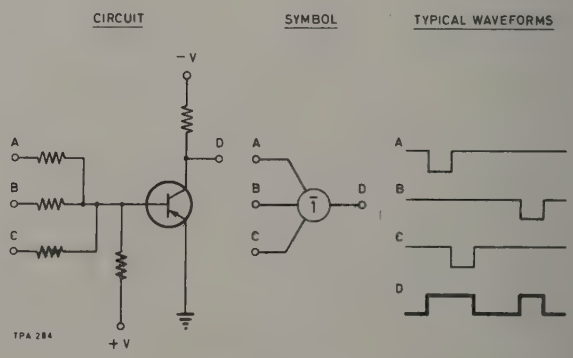


Fig. 3.5 NOR gate

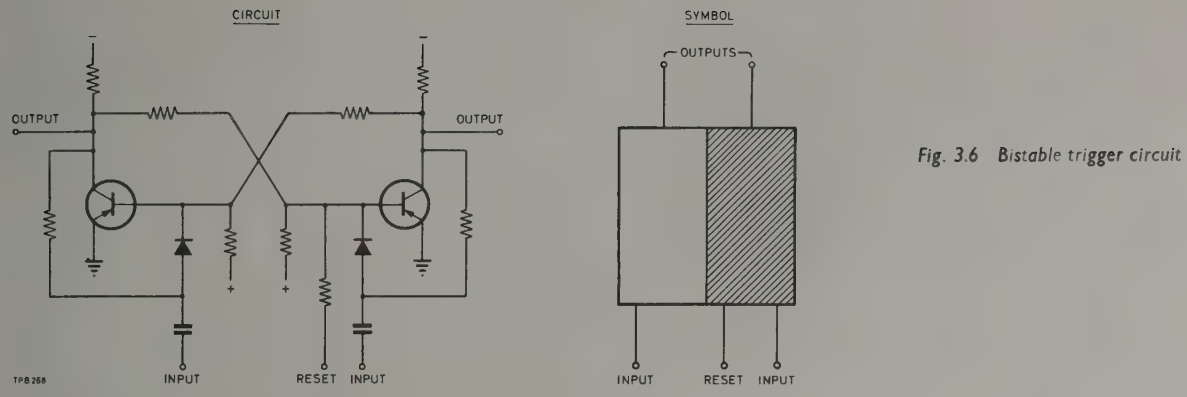


Fig. 3.6 Bistable trigger circuit

The NAND gate circuit is similar to that of the NOR gate, except that all inputs must be active before the output is inactive.

The most common form of bistable element, of the Eccles-Jordan type, may be considered as two inverter stages connected together so that the output of one drives the input of the other. A bistable element may be used as a counting element or a memory.

As a counting element the two inputs of the circuit are connected to a common input. The first pulse to arrive turns the bistable into one state; the second returns it to the original state, and so on. The bistable therefore completes one cycle for two cycles of the input waveform, thereby providing the divide-by-two function. By cascading such stages, division in binary form is achieved, and by the use of gates, division by any number may be achieved. A bistable element is shown in Fig. 3.6. It will be seen from the circuit that activating the left hand input produces an output from the right hand side; to simplify the understanding of logic diagrams, the outputs are crossed over, and in the logic symbol activating the left hand input will activate the left hand output.

3.2 TM 7448: 10 Mc/s D.C.U. with MEMORY and READOUT DRIVE

D.C.U.

The counting unit comprises four identical bistable circuits connected so that the switching sequence results in 1-2-4-8 weighted working.

Fig. 3.7 shows the logic diagram of the D.C.U. The first three bistable circuits are cascaded for normal binary division, while the fourth is two line driven - one side from the output of the third bistable and the other side directly from the output of the first.

When the decade is reset the AND gate is opened and is held in this state until the count of '8'. On the count of '8', the output from the third element switches the fourth to the '1' state and this action closes the gate. The tenth count now cannot affect the second bistable but switches the fourth to '0' which leaves the decade in its original state and ready to recycle.

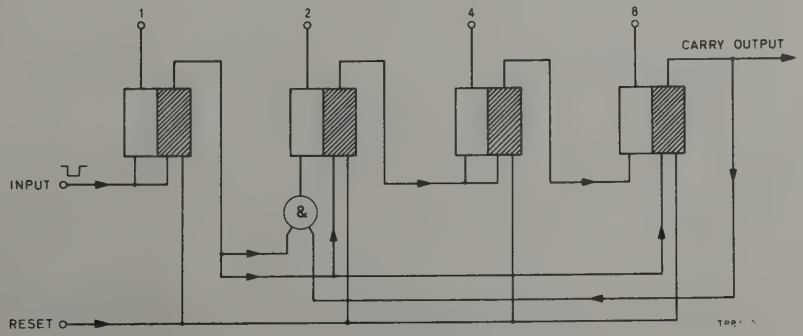


Fig. 3.7 D.C.U. logic diagram

Memory

The eight line output from the D. C. U. is taken through the memory transfer AND gates to the memory bistable circuits.

When the memory is off, the gates are held open by a d. c. signal applied to the transfer command line; this allows the memory to follow, directly, the state of the D. C. U. while it is cycling.

When the memory is on, the gates are held closed until a pulse is applied to the transfer command line. This pulse is applied at the beginning of the display period and opens the gates, allowing the memory to be set up to the same state as the D. C. U. 's. At the end of the pulse the gates are closed, and so the D. C. U. is prevented from having any further effect on the state of the memory, and hence the display.

Binary to decimal decoding, from the memory to the readout, is based upon the bi-quinary approach and is shown in Fig. 3.8. The first

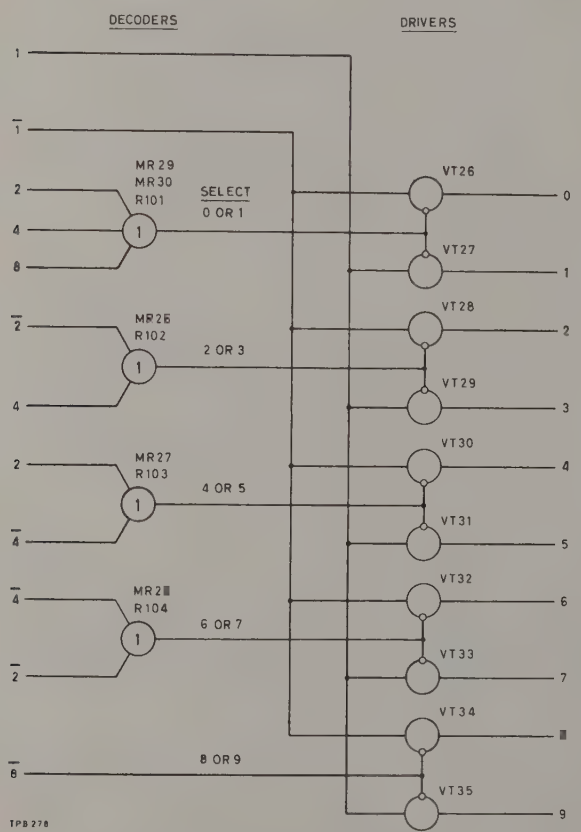


Fig. 3.8 Decoding logic diagram

memory bistable selects the odd or even digits in the readout drivers and the outputs from the other three memory bistables are decoded to select any particular digit. The effective operation of the OR gates is that a '1' input on any leg of any gate will inhibit the corresponding readout drivers thus preventing the selected '1' or '$\overline{1}$' driver input from being delivered at the output. All inputs, of any gate, at '0' allow the appropriate drivers to function.

3.3 TM 7450/1: 10 Mc/s DUAL DECADE

The time base delivered at the output is synchronized to the output from the first bistable of the 10 Mc/s decade (VT1, VT2). That is, the pulse from the first bistable appears as the time base at the frequency selected. This time base frequency is determined by time base selection gates - via the 'window' bistable for frequencies from the 250 kc/s D. C. U. 's.

Fig. 3. 9 shows the logic diagram for the 10 Mc/s dual decade (time base dividers).

The time base divider is triggered by either the 1 Mc/s standard from the oscillator, for frequency or period measurements, or the output from the B amplifier, for multiple period measurements. Gates select the appropriate signal and pass it to an amplifier which drives the divider bistable circuits and an inhibited AND gate. This gate (VT11) will operate only when the T9 condition is present and the $\overline{S11}$ is not; that is only when the instrument is in the frequency measuring or test modes, and the TIME BASE switch select the fastest time base. The output from this gate is passed via an OR gate for use as the time base for these functions.

Operation of the two dividers is basically the same as that of the D. C. U. TM 7448 , with the '1' state outputs of the first and fourth bistables gated.

The frequency of the time base delivered at the output is determined by the time base selection gates. The gate for the particular time base required is selected by the appropriate 'T' and 'S' d. c. conditions as produced by the TIME BASE and FUNCTION switches respectively (refer to the logic signal chart in the Function unit manual).

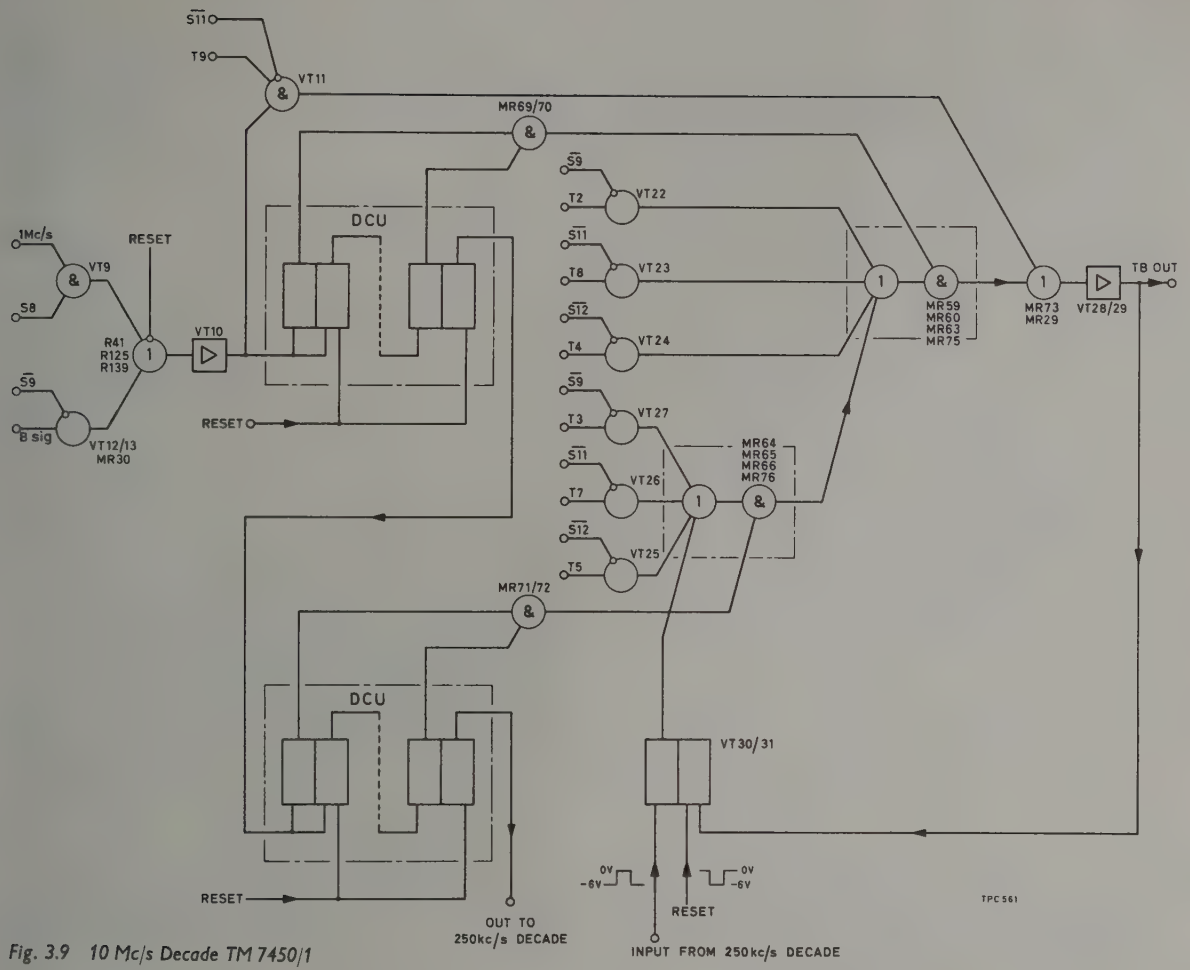


Fig. 3.9 10 Mc/s Decade TM 7450/1

Subsequent gating delivers the desired frequency signal to one input of an AND gate, the other input being energized by the gated outputs of the first D. C. U.

Lower frequencies, as derived from the 250 kc/s D. C. U. 's, set the 'window' bistable whose output is gated, effectively, with the output from the first bistable of the first D. C. U. and used as the time base pulse. This pulse is fed back to reset the bistable which is then ready to be set up again by the next pulse from the 250 kc/s D. C. U. 's.

3.4 TM 7451: 250 kc/s DUAL DECADE

The 250 kc/s dual decade functions in a way similar to that of the 10 Mc/s decade. No input gating is required, however, as each decade is driven by the previous one, and the output gating is also less complex. The logic diagram is shown in Fig. 3.10.

When a reset pulse is applied, the 250 kc/s decades reset to '9' so that the first input pulse to the dividers will immediately produce an output pulse to open the main counter gate. Resetting these dividers to '0' would introduce a delay, equal to the transmission time of the dividers, before the main gate was opened. i.e., if 100 sec time base was selected, counting would not take place for 100 seconds, when the count gate would be opened; another 100 seconds would then elapse before a display was available.

3.5 TM 7447: DISPLAY CONTROL, RESET, and MEMORY FOR FIRST D.C.U.

A stop signal from the Range unit passes through the inhibit gate, in the absence of a reset

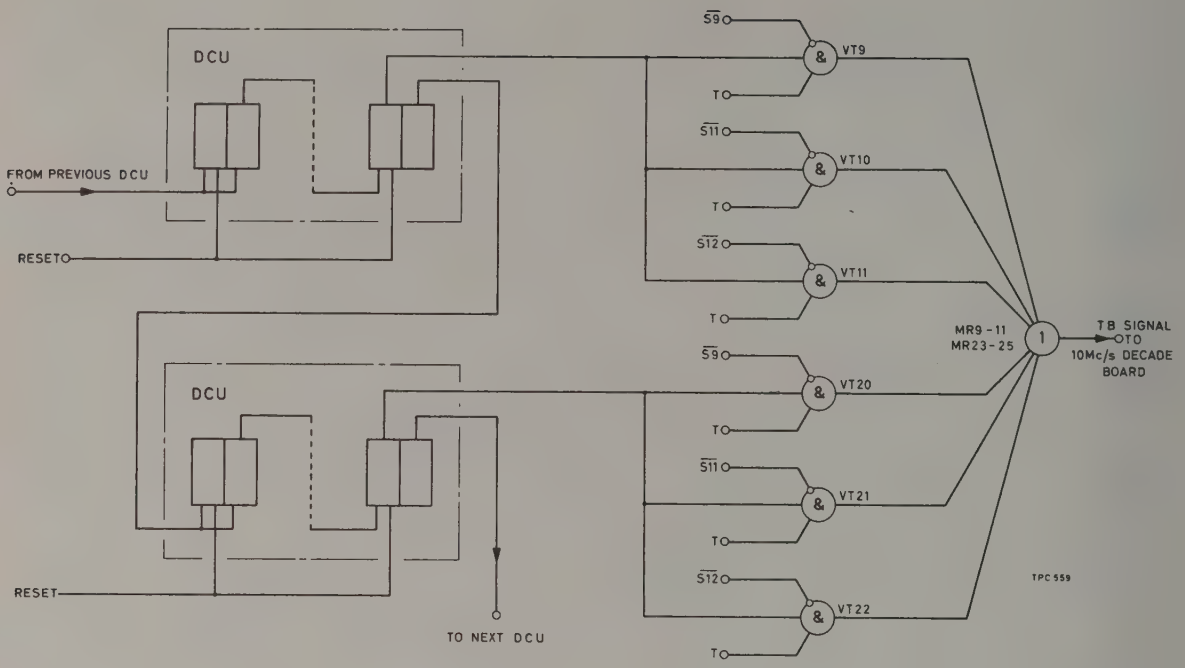


Fig. 3.10 250 kc/s Dual Decade TM 7451

inhibit signal, and sets the bistable. The bistable output is delayed by a time determined by the DISPLAY control, and after amplification triggers a pulse generator to produce a reset pulse of 25 μsec duration. This pulse is fed back to reset the bistable.

The stop signal is also used to trigger the print command and memory transfer pulses.

Also on the board is the memory and read-out decoding and drivers for the first D. C. U.; these are exactly the same as for TM 7448, 10 Mc/s D. C. U., which is described in section 3.2.

3.6 LOGIC DIAGRAM

A logic diagram showing the interconnecting of the more important logic elements in main Counter, Range and Function units, is given in the Range unit manual.

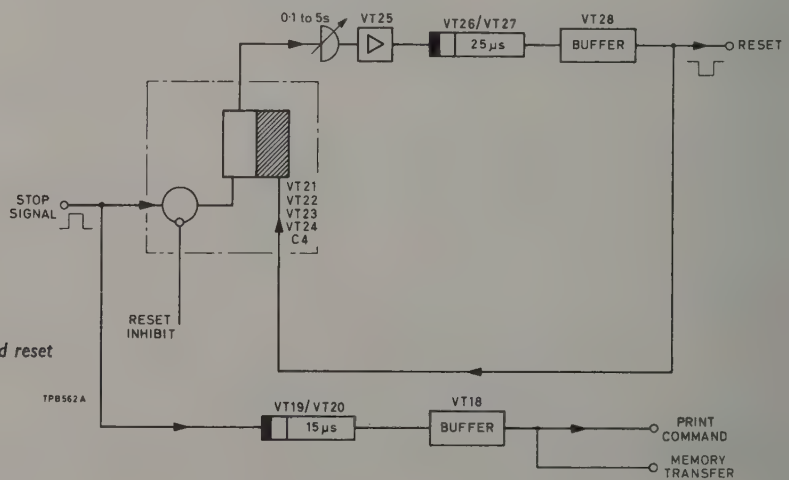


Fig. 3.11 Logic diagram for display control and reset

Section 4

Technical description

4.1 POWER SUPPLY

The power supply comprises five regulators and features transient short circuit protection.

+20 V regulator

The supply is derived from the standby transformer T101, as part of the supply (+22.5 V) is used for the crystal oven. Because it is contained in the control loop, the +20 V line achieves a high degree of stability, whereas the +22.5 V line varies slightly with the +20 V line loading.

The +20 V supply line is compared with the +20 V reference voltage, obtained from Zener diode MR13, in transistor VT2. The collector current of this transistor controls the regulator transistor, VT101.

Under normal conditions, transistor VT4 is biased on and supplies current for the Zener diode. When the load on the line becomes excessive a potential drop is developed across resistor R104, large enough to turn off VT4. The resulting drop in Zener voltage causes the current in VT2 to fall, which in turn reduces the current in transistor VT101; the output voltage now falls until equilibrium is reached. As the load is increased, there is a very rapid fall in voltage, until under short circuit conditions the voltage drops to zero with very little current flowing (see Fig. 4.1). In order to restore the supply, it must be switched off, and then on again.

−20 V regulator

The -20 V supply is derived from the main transformer T102; transistor VT102 is the series regulator. The -20 V output is compared with the +20 V supply in VT5, and the output of this transistor is used to control the series regulator. Transistor VT3 forms the basis for a current source and limiting circuit similar to that in the +20 V supply.

As the +20 V line is used as the reference voltage for this supply, it follows that failure of the +20 V regulator results in the collapse of the -20 V line.

−18 V regulator

The -18 V supply is derived from the -20 V line via the series regulator VT105.

The long-tailed pair, VT15, VT16, compares the reference voltage obtained from the Zener diode MR24, with the portion of the output voltage derived by resistor R34 and RV1. The output of the long-tailed pair feeds an emitter follower, VT14, which in turn supplies the base current of the regulator transistor, VT105.

Since this supply is derived from the -20 V line, the short circuit protection of the -20 V line, also covers the -18 V regulator.

+6 V regulator

The +6 V line is compared with the -18 V line in transistor VT8. A current source and limiting circuit is formed round transistor VT13, similar to those previously described, and the collector current divides between the collector of VT8 and the base of VT10. Transistor VT10 drives the emitter follower VT7, which controls the series regulator, VT103.

In the event of an overload, the potential drop across R103 is such that the current through VT13 is reduced, and in consequence there is insufficient current available to drive VT10. The current at the base of VT103 is therefore limited and the output voltage is reduced. As the overload is increased, the output voltage falls until eventually VT10 is switched off and the output voltage falls to zero.

With the circuit as described so far there would be a tendency for the output voltage and current to remain at zero when the supply is switched on. Transistor VT12 and its associated components are designed to ensure correct switching on.

When the counter is switched on, VT12 will be forward biased through the base emitter junction of VT103. A large current will flow as capacitor C5 charges up and aims towards the potential determined by resistors R16 and R17. When this potential is reached, VT12 will be switched off, but during the charging process current will have passed through the series regulator, ensuring that the supply turns on.

Since the +6 V supply uses the -18 V line for its reference, failure of the +20 V, -20 V or -18 V lines will cause the +6 V line to collapse.

—6 V regulator

This supply is essentially similar to those previously described; as in the +6 V regulator, the reference voltage is the -18 V line.

When overloaded, the potential drop across resistor R102 reduces the current through VT11 and hence the current available for the series regulator, VT104. As the load is increased the voltage reduces, and under short circuit conditions the current is limited by the value of R102 and the potential drop across the diodes MR21, MR22 and MR23.

Failure of the -18 V, +20 V or -20 V lines will cause the -6 V line to collapse.

Overall performance

Fig. 4.1 compares the regulation curves of the various supply lines, and Table 4.2 shows the effect upon each supply line when any one is short circuited. It is seen from the regulation curves that the negative supply rails recover from overload, whilst the positive lines require the instrument to be switched off, then on again.

The power supply is mounted on two boards; one board carries the -18 V, +6 V and -6 V supplies, and the other board carries the +20 V and -20 V supplies.

4.2 TM 7448: 10 Mc/s D.C.U. with MEMORY and READOUT DRIVE

D.C.U.

The four circuits which comprise the decade counting unit are conventional bistable trigger circuits which are triggered by a negative going pulse

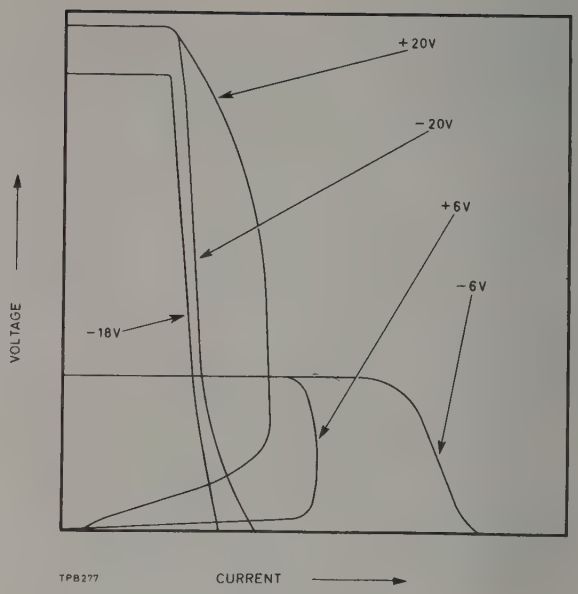


Fig. 4.1 Regulation curves

TABLE 4.2

Effect of short circuit

LINE SHORTED	CONDITION OF OTHER LINES				
	+20 V	−20 V	−18 V	+6 V	−6 V
+20 V	—	OFF	OFF	OFF	OFF
−20 V	+20 V	—	OFF	OFF	OFF
−18 V	+20 V	OFF	—	OFF	OFF
+6 V	+20 V	−20 V	−18 V	—	−6 V
−6 V	+20 V	−20 V	−18 V	+6 V	—

input. This input is differentiated into positive and negative going spikes, the positive spike being used to turn off the conducting transistor.

The switching speed of the circuits is increased by clamping the reverse base potentials with diodes MR1 and MR3 (referring to the first bistable circuit) which also provide reverse breakdown protection. A further increase in speed is achieved with diodes MR17 and MR18 (again referring to the first circuit)which, on alternate pulses, shorten the charging path of the input capacitors.

Readout drivers

The output of each drive transistor connects to the appropriate cathode on the readout tube. One such transistor driver is shown in Fig. 4.2.

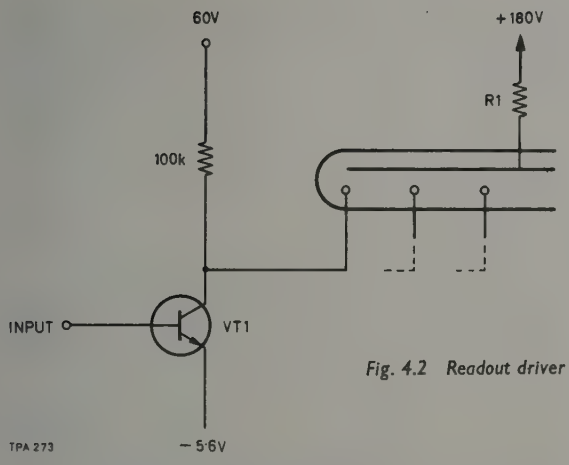


Fig. 4.2 Readout driver

A potential sufficiently large to strike the tube, is developed only when VT1 is conducting. The value of series resistor R1 is governed by the tube current and voltage supply. The drive transistors must have breakdown voltages in excess of 60 V.

4.3 TM 7449: 250 kc/s D.C.U. with MEMORY and READOUT DRIVE

This decade is a slower speed version of the 10 Mc/s D. C. U. Slower transistors are used, and there are no base protection diodes. The memory gating, memory, decoding and readout driving circuits are identical to those in the 10 Mc/s version, TM 7448.

4.4 TM 7450/1: 10 Mc/s DUAL DECADE

The input gating to the 10 Mc/s decade is accomplished with transistors VT9, VT10, VT12 and VT13.

A 1 Mc/s signal from the oscillator is fed into VT9, whose collector is supplied by the time base signal, S8. If S8 is present (i.e., -6 V) the inverted 1 Mc/s is fed to amplifier VT10, the output of which triggers the decade. The reset signal is applied to the base of VT10; this avoids breakthrough of the 10 Mc/s signal when the instrument is being reset.

The B amplifier output is fed to VT12 whose output is clamped to earth by VT13 unless the multiple period select signal, $\overline{S9}$, is at 0 V. If $\overline{S9}$ is at 0 V, the output of VT12 is fed to the amplifier.

The two 10 Mc/s decades are identical to the D. C. U. 's described for TM 7448. The outputs from the first and fourth bistables open gate MR69, MR70 on the count of ten (not the count of nine; this is because the positive going-edge of the input is used to trigger the D. C. U.).

Each decade is associated with three transistor gates; these are the time base selection gates. One is used for frequency measurement, one for period measurement and one for multiple period measurement; the six gates are similar, but that used for multiple period is inherently faster since is operates at 1 Mc/s.

The 'window' bistable is a conventional circuit. The reset signal is negative going (0 to -6 V) and switches on VT30; the input from the 250 kc/s decades is positive going (-6 V to 0) and switches off VT30.

4.5 TM 7451: 250 kc/s DUAL DECADE

The decades on this board are, again, identical to those described for TM 7448.

Each decade drives three transistor gates, one each for frequency measurement, period measurement and multiple period measurement. Fig. 4.3 shows one of these gates.

The collector supply is controlled by the TIME BASE switch so that the transistor is energized for only one time base switch position. The FUNCTION switch controls the supply of large d. c. bias currents to the transistor base, through R1, by providing -6 V or 0 V. The $\overline{S}$ signal at 0 V is required for the gate to operate, and if it is not provided the -6 V supplied provides sufficient current to saturate the transistor and so override the time base signal drive.

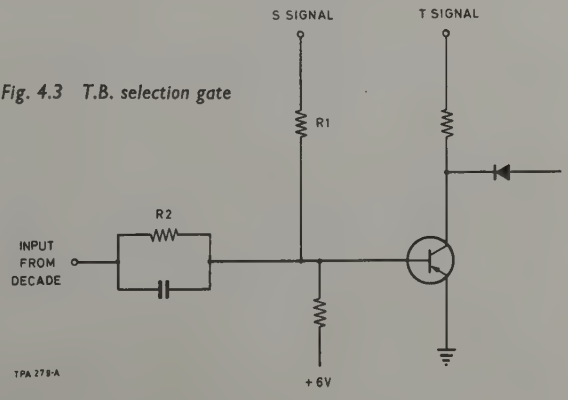


Fig. 4.3 T.B. selection gate

Therefore, for the transistor to pass the time base signal, the collector must be supplied with -6 V and the $\overline{S}$ signal applied so that R1 is left floating and the time base signal applied to the base.

4.6 TM 7447: DISPLAY CONTROL, RESET, and MEMORY

Just prior to the arrival of a stop signal (i.e., the Counter still counting), the transistors in the system will be in the states shown :

VT21	MR6	VT22	VT23	VT24	VT25	VT26	VT27	VT28
ON	*OFF*	*OFF*	*OFF*	*OFF*	*OFF*	*OFF*	*ON*	*OFF*

A -5 V to 0 V positive going stop signal turns off transistor VT21, allowing C4 to charge towards -20 V. At approximately -6 V, VT23, whose emitter is clamped at -5.2 V, will conduct. This turns on VT24 which clamps the negative end of C4 to -6 V.

VT23 also turns on VT25 which drives the reset generator VT26/VT27, producing a negative going reset pulse of approximately 25 μsec duration.

It is necessary to produce a fast discharge of C4 since the next stop pulse could occur in a time equal to the reset time plus 1 μsec gate time. The reset pulse is therefore used to turn on transistor, VT22; this turns on the silicon controlled rectifier, providing a low impedance path to earth for C4. The capacitor discharge will turn off VT23, VT24 and VT25. The reset pulse will also reset the stop bistable circuit, allowing VT21 to conduct and thus preventing C4 from charging.

A print command pulse is generated by feeding the stop signal into the generator VT19/VT20. This produces a negative going pulse of about 15 μsec duration.

Infinite display is achieved by applying a reset inhibit signal to the base of VT21, ensuring that this transistor is bottomed regardless of the applied stop signal level.

The rest of the circuitry on the board is the memory transfer gating, memory, decoding, and readout drivers for the first D. C. U. (housed in the Range unit) of the complete counter system. These circuits are dealt with in the description of the 10 Mc/s D. C. U., TM 7448.

4.7 TM 9894 : OSCILLATOR AND DIVIDER

The +12 V regulated supply to the oscillator, XL1, is derived from the +23 V line by a simple regulator circuit mounted on the board. Zener diodes MR2 and MR3 provide the reference voltage and RV1 adjusts the output from the regulator transistor VT1.

The 16 Mc/s output from the oscillator is amplified in VT2 and passed to the input of the divider, IC1 and IC2. This divider is simply two divide-by four circuits connected in series. The 1 Mc/s output from the divider is a. c. coupled into the 10 Mc/s dual decade (via the function unit).

4.8 TM 7446: UNITS INDICATOR

The oven lamp is controlled by the thermostat in the crystal oven and is switched by VT1 in the power supply.

The decimal point lamps are selected by the TIME BASE and FUNCTION switches, and further control is provided by the CLOCK switch which selects D1 or D2 when making a multiple period measurement.

Units indication is similarly performed, the selected functions being F1 and F3 for time, and F4 and F5 for frequency. MR13 selects the 'μs' lamp when F2 is operative.

The gate lamp is lit when the gate is open. As short gate times would not give the lamp time to light, if driven directly from the gate, the lamp is driven by a monostable circuit which may be held indefinitely in the quasi-stable state. During the display period the 'start' signal is at 0 V and the 'stop' signal at -6 V. Transistor VT1 will be on and VT2 off; VT3 will therefore be off. At the beginning of the gate period, the 'start' signal rises to +6 V, turning on VT2 and this in turn switches on VT3, lighting the gate lamp. VT1 will tend to turn on again, after a time governed by time constant C2R7. During this recovery time, or until the end of the gate period (when the 'stop' signal rises to 0 V) whichever is longer, VT2 is held on so that the gate lamp is illuminated.

Section 5

Maintenance notes

5.1 GENERAL

This section of the manual is intended as a general guide to the servicing of the instrument. In case of difficulties which cannot be resolved with the aid of this book please contact our Service Division at the address on the back cover or your nearest Marconi Instruments representative. Always mention the type number and serial number of your instrument.

The basic Counter incorporates only one preset, in the -18 V line, and this should need no adjustment unless an associated component is replaced.

This instrument uses semiconductor devices which, although having inherent long term reliability and mechanical ruggedness, are susceptible to damage by overloading, and excessive heat or radiation. Avoid hazards such as prolonged soldering, strong r.f. fields or other forms of radiation, short circuits, or use of insulation testers.

It should be noted that, with the exception of those used in the transformer assemblies, American Standard screw threads are used throughout this instrument, and in all plug-in units.

5.2 FUSES

The Counter is protected by two delay fuses (1 A for 190-260 V; 2 A for 95-130 V) connected between the mains plug and the mains filter. One fuse is in the live line, and the other in the neutral line. The fuse holders are mounted on the rear panel.

5.3 REMOVING COVERS

Remove the screws securing the covers at the rear of the instrument; there are two screws fixing the top cover and three the bottom. The covers can now be removed by sliding them out of their guides.

5.4 TRANSFORMER CONNECTIONS

The Counter can be adjusted to operate from any supply in the ranges 100 to 150 V and 200 to 250 V, 45 to 500 c/s, the adjustments are made to both the mains and oven transformers. For the higher voltage range the two mains transformer primaries are linked in series; for the lower voltage range the primaries are linked in parallel. When the primaries are linked, the supply is connected to taps selected according to the supply voltage.

The links to select the range, are shown on the cover over the transformer taps; each side of the cover shows the links for one range of voltages.

For a particular supply, connections similar to those for the mains transformer must be made on the smaller oven transformer. These links are shown on the tag cover as for the mains transformer.

5.5 ADJUSTING THE 1 Mc/s STANDARD

The accuracy of the gate times and timing signals is determined by the internal standard frequency. Before checking the frequency, the instrument should be thoroughly warmed up (see Sect. 2.1).

With the FREQ A function selected, select a 10 second gate time and set the DISPLAY control for a short but readable display. Apply a 10 Mc/s standard frequency to the INPUT A socket, on the range unit, at a level sufficient to trigger the counter.

Adjust the trimmer on the oven so that the counter displays 0000000.0. The adjustment must be made with the top cover of the instrument removed (see Fig. 5.1 for the location of the trimmer).

This procedure sets up the counter to the same accuracy as the applied standard frequency with an additional possible error of ±1 part in 10^8 (i.e., ±1 count when counting 10 Mc/s over 10 seconds). The error can be reduced to ±1 part in 10^9 if a 100 Mc/s standard is available, but, conversely, if 1 Mc/s is the standard being used the additional possible error is ±1 part in 10^7.

5.6 ACCESS TO READOUT TUBES

CAUTION To avoid damaging transistors, do not remove or replace readout tubes while the Counter is switched on.

To obtain access to the readout tubes proceed as follows :-

Withdraw the top and bottom covers sufficiently to expose the screws retaining the front panel, and remove these screws (two in the top and two in the bottom nearest the front of the Counter). This frees the front panel. Pull out the front panel to the extent of the cable-form which is wired to the switches etc.

The tubes can now be removed by pulling them from their sockets.

NOTE : When fitting a tube, see that the numerals in it are upright before pressing the tube into position.

5.7 ACCESS TO UNITS INDICATOR LAMPS

Remove the instrument front panel as described in Section 5.6. - Access to Readout Tubes. The units indicator board, the indicator block (which holds the lamps in the correct positions) and the engraved panel, can now be removed as one unit by withdrawing the screw holding them to the fixing bracket (at the right-hand end viewed from the front of the instrument) and unplugging the board from the socket.

To replace faulty indicator lamps, the printed circuit board must be detached from the block to allow the lamps to be unsoldered. When replacing the board, make sure that all the lamps are located in the holes in the block.

5.8 UNITS INDICATOR CHECK

See Function unit manual.

5.9 REMOVING PLUG-IN CIRCUIT UNITS

CAUTION To avoid damaging the transistors, do not remove or replace any of the plug-in boards while the Counter is switched on.

The plug-in boards can easily be removed by using the extractor supplied. To remove a board, locate the lips on the extractor with the holes in the corners of the board and pull up firmly.

To prevent boards being plugged into the wrong socket, all except the two regulator boards are slotted to mate with a key in the appropriate socket. This key is a 'T' piece which can be removed to allow an extender board to be used when servicing the unit. If the 'T' piece is removed it must be replaced in the correct position in the socket (next to the black mark).

5.10 POWER UNIT CHECKS

Test Gear required :-

Variable Mains Transformer, e.g., Variac.
Voltmeter/Ammeter; Avometer, Model 8.
Wattmeter.

Power consumption

Remove the printed circuit boards, Range and Function units, and connect the Counter to the variable mains transformer via the wattmeter. Adjust the transformer for normal mains voltage. The reading on the wattmeter should not exceed 3.5 W with the SUPPLY switch in the STANDBY position, and 12 W with the switch in the COUNTER position.

Set the variable transformer to 0 V.

Insert the two regulator boards TM 7452/1 and TM 7453 into their sockets. With the SUPPLY switch in the COUNTER position, adjust the variable mains transformer to normal mains voltage. The reading on the wattmeter should not exceed 19 W. Should it become apparent, when adjusting the transformer, that the reading on the wattmeter will considerably exceed the limit, set the variable transformer to 0 V and check the supply rails for short circuits to earth.

−18 V supply line

The preset controlling this line should need no adjustment unless some component in the regulator circuit is replaced. The position of the preset is shown in Fig. 5.1.

To set up the line, monitor with a voltmeter at any convenient point on the -18 V rail and adjust the potentiometer until the meter shows 18 V $\pm\frac{1}{4}$ V.

Effect of short circuit on power supplies

Should the +20 V line or the +6 V line be short circuited, the supply can be restored to its normal potential by switching the SUPPLY switch to STANDBY and then returning it to COUNTER. All other lines (e.g., the negative supplies) will recover from short circuit conditions and regain their normal potentials once the short circuit has been removed.

Supply line loading

The loading of the supply lines should be of the order :

+20 V	1 A
-20 V	0.8 A
-18 V	0.5 A
-6 V	2.5 A
+6 V	1.5 A

TABLE 3

Frequencies available at TIME BASE OUT connector

Operating mode	*Time base switch position*								
	T1	*T2*	*T3*	*T4*	*T5*	*T6*	*T7*	*T8*	*T9*
S11 FREQ* (F4, F5)	.01 c/s	.1 c/s	1 c/s	10 c/s	100 c/s	1 kc/s	10 kc/s	100 kc/s	1 Mc/s
S12 PER* (F1, F3)	-	-	-	100 kc/s	10 kc/s	1 kc/s	100 c/s	10 c/s	1 c/s
S9 MULT PER* (F2, F7, F10)	-	B/10	$B/10^2$	$B/10^3$	$B/10^4$	$B/10^5$	$B/10^6$	$B/10^7$	$B/10^8$

NOTES :

The frequencies shown are continuously available only when the DISPLAY control is set to INF.

* Terminology pertains to TM 7557A and TM 7558A plug-in units. Terminology may change with other units.

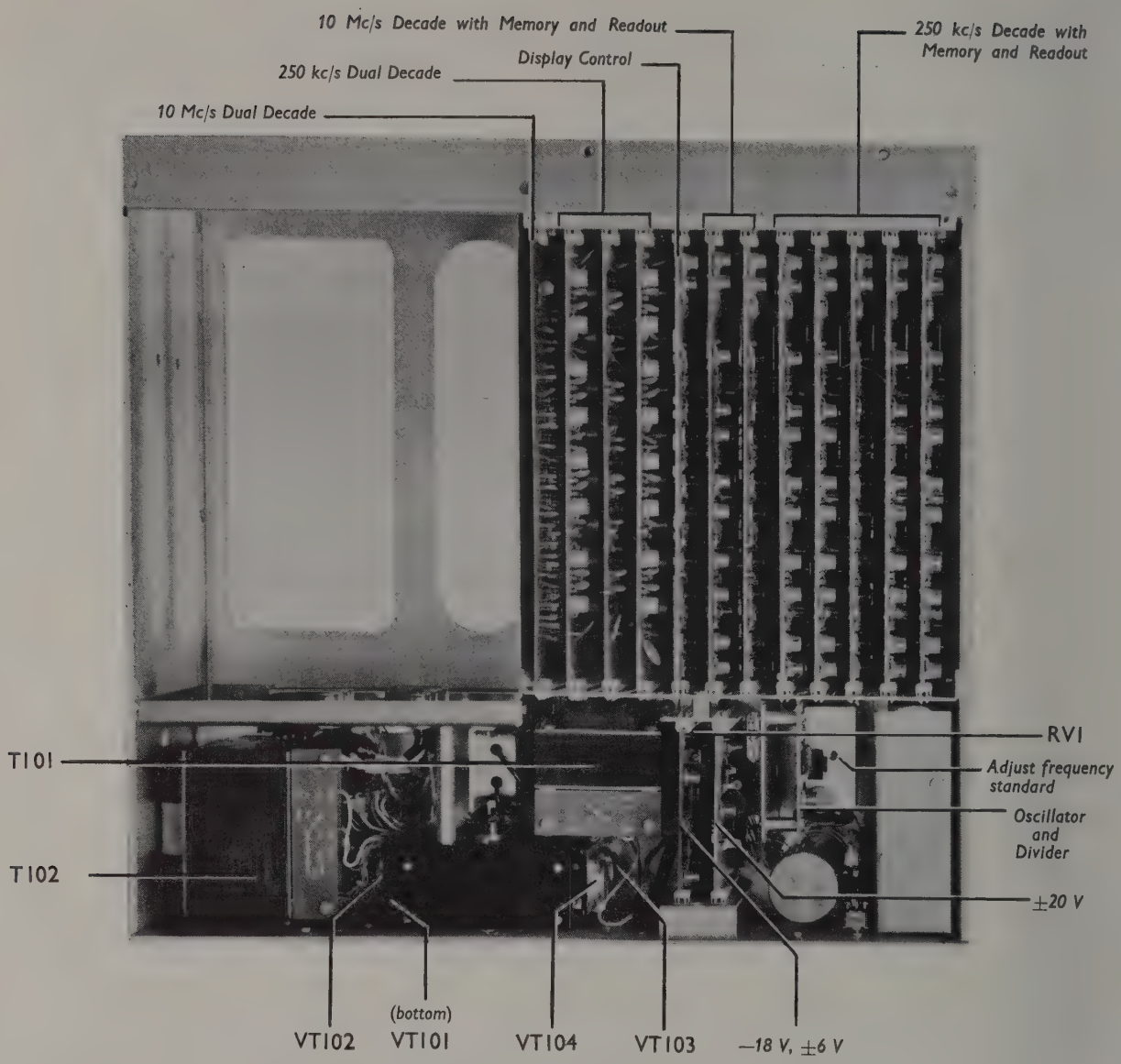


Fig. 5.1 Printed board layout

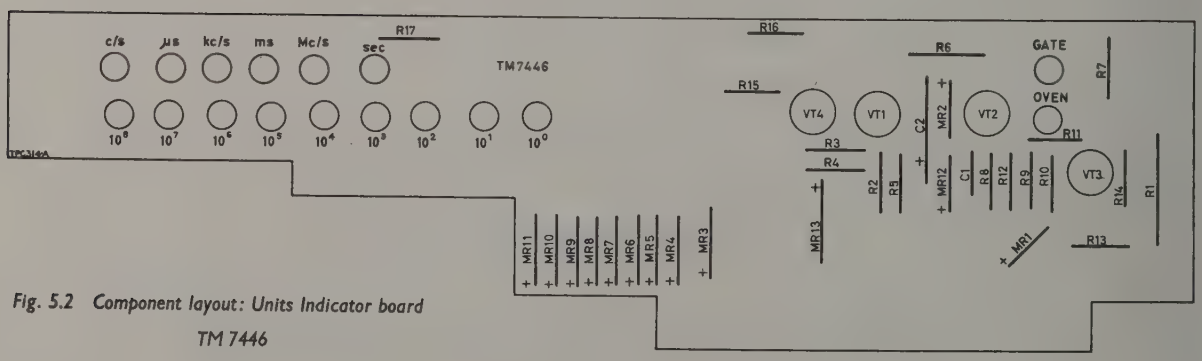


Fig. 5.2 Component layout: Units Indicator board TM 7446

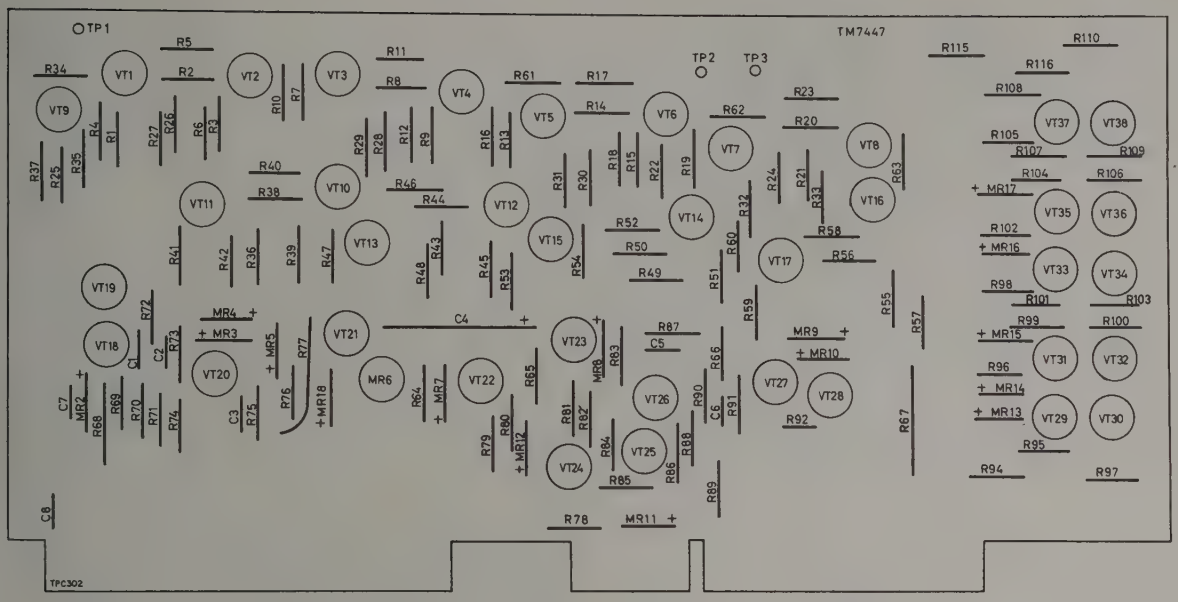


Fig. 5.3 Component layout: Display Control board TM 7447

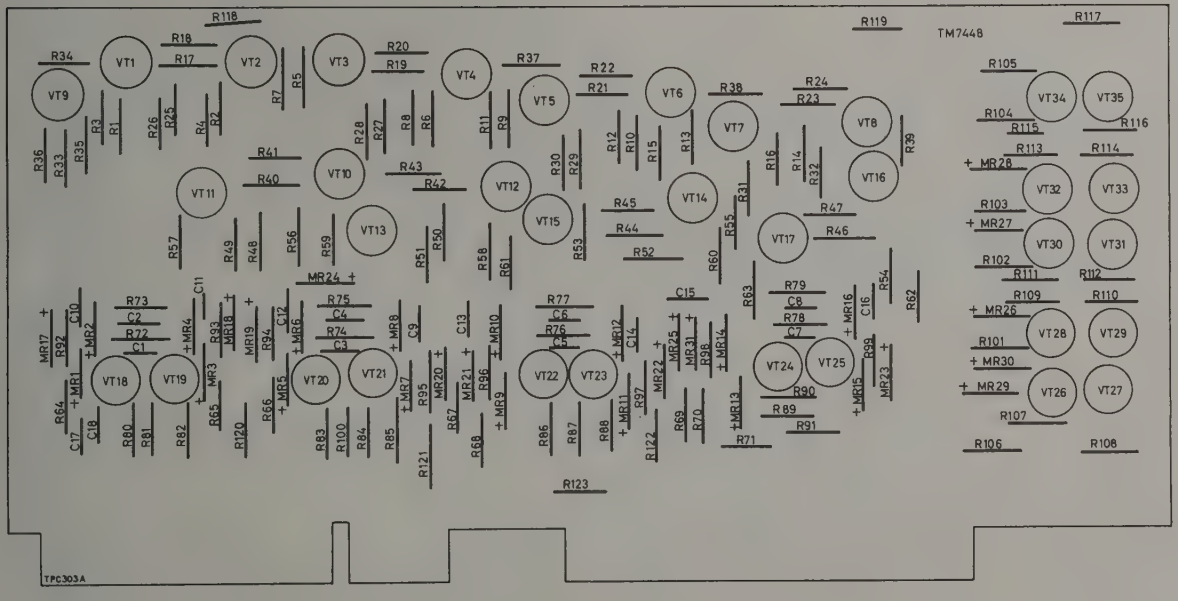


Fig. 5.4 Component layout: 10 Mc/s Decade with Memory and Readout TM 7448

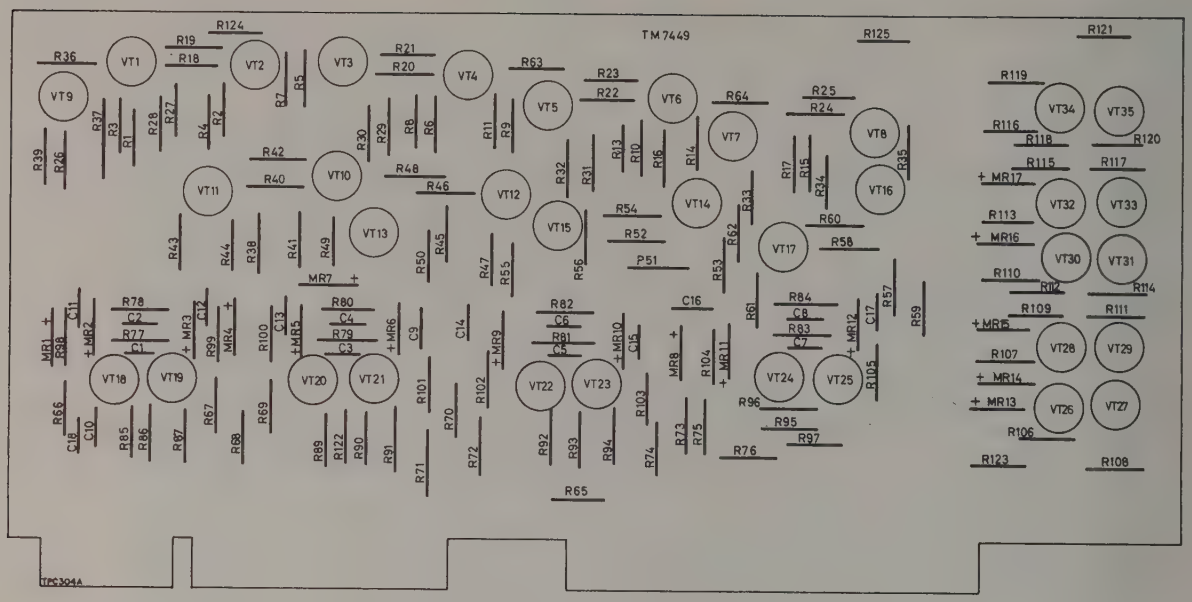


Fig. 5.5 Component layout: 250 kc/s Decade with Memory and Readout TM 7449

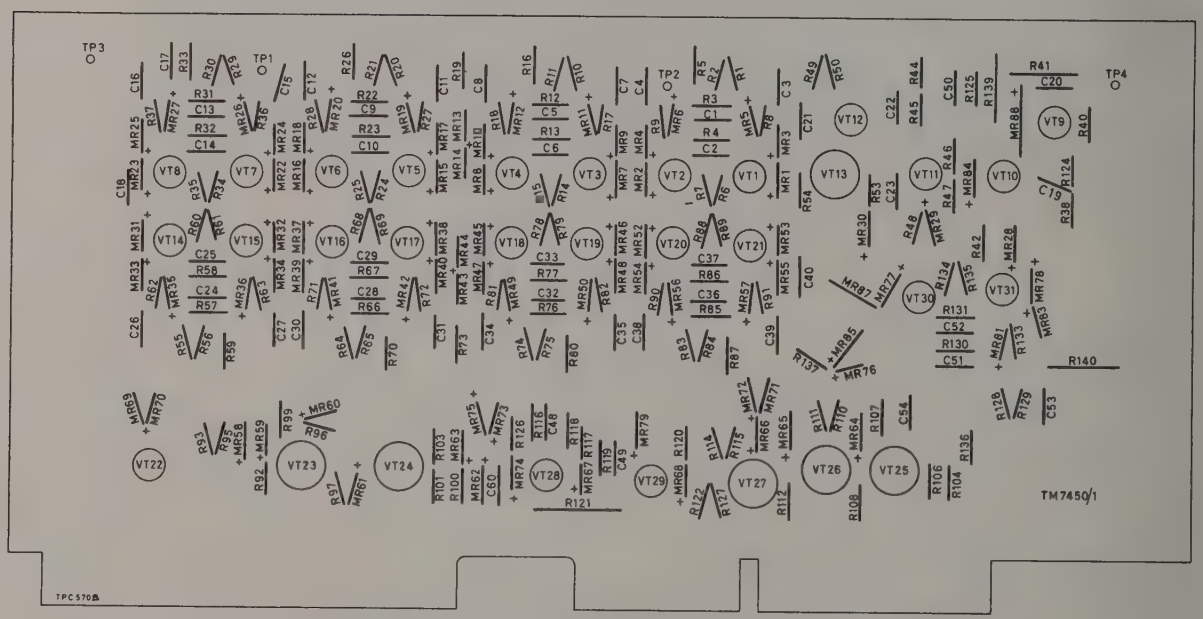


Fig. 5.6 Component layout: 10 Mc/s Dual Decade TM 7450/1

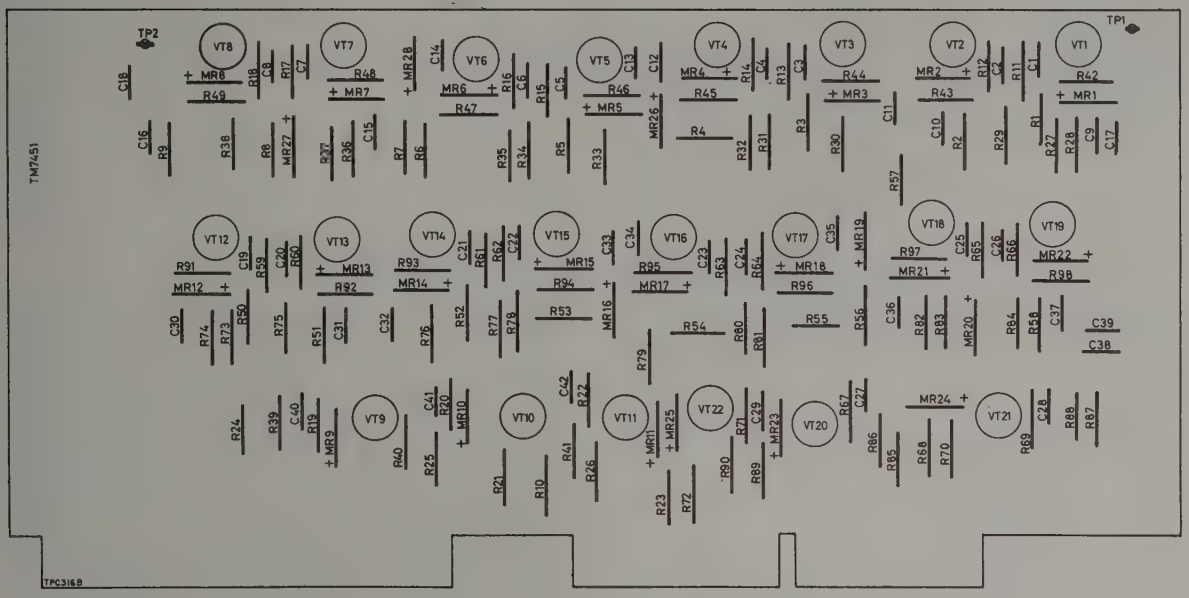


Fig. 5.7 Component layout: 250 kc/s Dual Decade TM 7451

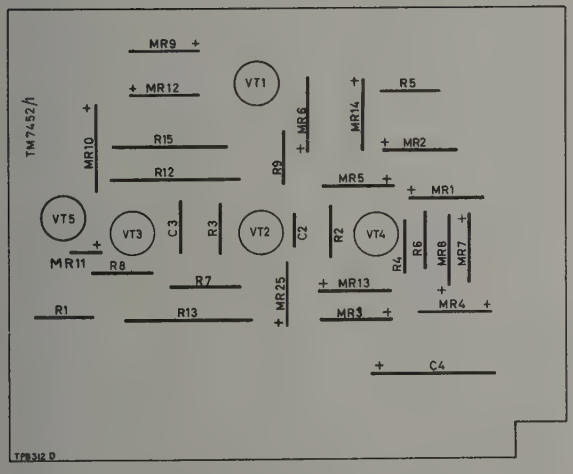


Fig. 5.8 Component layout: Regulator board; ±20 V TM 7452/1

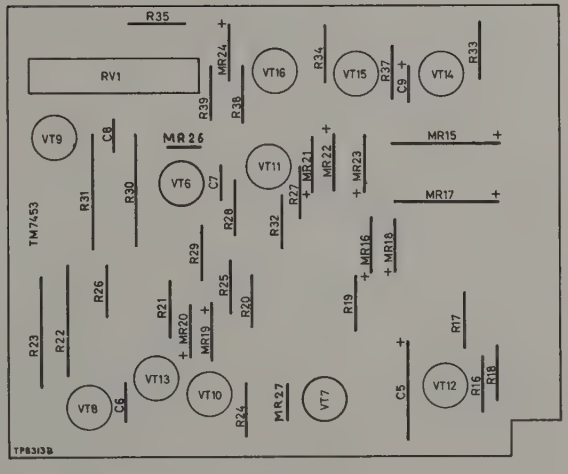


Fig. 5.9 Component layout: Regulator board; −18 V, ±6 V TM 7453

Section 6

Replaceable parts

Introduction

This section lists replaceable parts in alphabetical order of their circuit reference, with miscellaneous parts at the end of the list. A separate parts list is given for each circuit diagram. The following abbreviations are used:

Carb	:	carbon
Cer	:	ceramic
DPDT	:	double pole, double throw
Elec	:	electrolytic
G	:	conductance
Min	:	minimum
Plas	:	plastic
Pos	:	position
SPST	:	single pole, single throw
Var	:	variable
WW	:	wire wound
*	:	selected during test; nominal value listed

Note: Throughout the lists resistor wattages are referred to 70°C unless otherwise stated.

Ordering

When ordering replacement parts address the order to our Service Division. Specify the following information for each part required.

1) Type and serial number of instrument
2) Board title and TM number
3) Circuit reference
4) Description
5) M.I. code number

If a part is not listed, state its function, location and description when ordering.

Semiconductor types

The M.I. code listed against each diode or transistor refers, generally, to more than one type of semiconductor. These types are listed below against the M.I. code number.

DIODES

90441: CMC4300164; 1N759A
90442: CMC4300165; 1N753A
90443: CMC4300172; 1N718A; HS2150
90444: CMC4300178; 1N708A; 1N752A; 1S7056A
90445: CMC4300179; EVR20B; 1R203
91003: CMC4300120; 1N34A/G; 1N34A
91004: CMC4300141; S3237G
91005: CMC4300142; 1N458
91006: CMC4300158; 1N3063; U16003
91007: CMC4300160; S555G; 1N995; HD1870
92002: 1S923
92003: CMC4300149; 1N2069; 1N2069A; CER68C
92004: CMC4300150; CER71A
92005: CMC4300161; SOD100D
93003: CMC4300169; 1N3562; LT2026
97002: CMC4906078; 2N1595
28357-548: 1S44
28371-429: Z5B78

TRANSISTORS

95008: CMC4906009; 2N404
95010: CMC4906041; SM644
95012: CMC4906047; 2N1303
95013: CMC4906049; SP1685; 2N669
95014: CMC4906052; 2N1038; CP1213
95015: CMC4906060; SM2034; 2N976
95016: CMC4906065; SM2035; SM642
95018: CMC4906077; SP1686; 2N1544
95509: MM1613
95511: CMC4906038; 2N708; S5900; U16004
95512: CMC4906043; SM4998; U16005
95513: CMC4906045; 2N709; U16006
95514: CMC4906063; U16007; 2N1990S; SM2128
95515: CMC4906071; SM5902; U16008; CET247
95516: CMC4906072; U16009; 2N2369; CET248
95517: CMC4906073; SM5901; U16010; CET249
95519: 2N2369S; U16011
96501: CMC4906048; 2N1302
97001: CMC4906076; W112; 2N2386
28433-456: MPS6519
28434-937: 2N4234
28452-787: BC108
28453-816: MM1711

Main chassis

Circuit reference	Description	M.I. code
C101	Cer 390pF ±10% 500V	26383-217
INDICATING LAMPS		
ILP101	Indicator tube	28224-312
ILP102	Indicator tube	28224-312
ILP103	Indicator tube	28224-312
ILP104	Indicator tube	28224-312
ILP105	Indicator tube	28224-312
ILP106	Indicator tube	28224-312
ILP107	Indicator tube	28224-312
ILP108	Indicator tube	28224-312
DIODES		
MR101	High G	MIP 91004
MR102	High G	MIP 91004
MR103	High G	MIP 91004
MR104	High G	MIP 91004
MR105	High G	MIP 91004
MR106	High G	MIP 91004
MR107	High G	MIP 91004
MR108	High G	MIP 91004
MR109	High G	MIP 91004
RV201	250kΩ (part of DISPLAY switch)	25010-003
RESISTORS		
R101	Carb 18kΩ ±5% ¼W	24332-116
R102	Carb 18kΩ ±5% ¼W	24332-116
R103	Carb 18kΩ ±5% ¼W	24332-116
R104	Carb 18kΩ ±5% ¼W	24332-116
R105	Carb 18kΩ ±5% ¼W	24332-116
R106	Carb 18kΩ ±5% ¼W	24332-116
R107	Carb 18kΩ ±5% ¼W	24332-116
R108	Carb 18kΩ ±5% ¼W	24332-116
R109	Carb 6.2kΩ ±5% 1/10W	24331-304
R110	Carb 2.2kΩ ±10% 1/10W	24341-288
R111	Carb 56kΩ ±10% ¼W	24342-129
SWITCHES		
S201	12 pos TIME BASE	44326-417
S202	Push button RESET	23010-009
S203	DPDT GATE	23462-258
S204	SPST (with RV201) DISPLAY	25010-003
S205	SPST MEMORY	23462-252
S301	DPDT 1 Mc/s STD	23462-258
MISCELLANEOUS		
	Knob 11/16" dia	41141-206
	Knob 1" dia	41142-704
	Lamp 24V	23735-479
	Lamp lens	37485-704
	Lamp bracket	35342-126
	Display window	37551-701

For symbols and abbreviations see introduction to this section

Oscillator and divider TM 9894

Circuit reference		Description	M.I. code
CAPACITORS			
C1	Cer	0.1μF +50% -25% 30V	26383-031
C2	Cer	0.1μF +50% -25% 30V	26383-031
C3	Cer	0.1μF +50% -25% 30V	26383-031
C4	Cer	0.01μF +80% -20% 100V	26383-055
C5	Cer	0.1μF +50% -25% 30V	26383-031
C6	Plas	300pF ±10% 125V	26516-360
INTEGRATED CIRCUITS			
IC1	SN 7474N		28462-002
IC2	SN 7474N		28462-002
L1	Choke	100μH	23642-325
DIODES			
MR1	Power rectifier		28357-548
MR2	Zener		28371-429
MR3	Zener		28371-429
MR4	Power rectifier		28357-548
MR5	Power rectifier		28357-548
MR6	Power rectifier		28357-548

Circuit reference		Description	M.I. code
RESISTORS			
R1	Met ox	1.2kΩ ±7% TE $\frac{3}{8}$W/55°C	24552-082
R2	WW	47Ω ±5% 1$\frac{1}{2}$W	25123-037
R3	Carb	8.2kΩ ±10% $\frac{1}{4}$W	24341-308
R4	Carb	470Ω ±10% $\frac{1}{4}$W	24341-269
R5	Carb	3.9kΩ ±10% $\frac{1}{4}$W	24341-296
R6	Carb	220Ω ±10% $\frac{1}{4}$W	24341-258
R7	Carb	1kΩ ±10% $\frac{1}{4}$W	24341-280
RV1	WW	220Ω ±10% 1W	25811-015
TRANSISTORS			
VT1	General purpose		28453-816
VT2	Silicon planar		28452-787
XL1	16 Mc/s		28313-861

Power Supply: TM 7452/1, TM 7453, TM 7614/1

BL101	Blower		44715-022
CAPACITORS			
C2	Cer	0.1μF +50% -25% 25V	26383-031
C3	Cer	0.1μF +50% -25% 25V	26383-031
C4	Elec	10μF +50% -20% 35V	26414-121
C5	Elec	2μF +100% -20% 25V	26414-109
C6	Cer	1μF +50% -20% 15V	26383-029
C7	Cer	0.1μF +50% -20% 12V	26383-029
C8	Cer	0.22μF +50% -20% 6V	26383-034
C9	Cer	0.1μF +50% -20% 25V	26383-031

For symbols and abbreviations see introduction to this section

Circuit reference	Description	M.I. code
C101	Elec 2500µF +50% -20% 50V	26427-134
C102	Elec 2500µF +50% -20% 35V	52-TM7614/1
C103	Elec 2500µF +100% -20% 35V	26000-022
C104	Elec 5000µF +50% -20% 18V	53-TM7614/1
C105	Elec 500µF +50% -20% 25V	26417-175
C106	Elec 500µF +50% -20% 25V	26417-175
C107	Elec 500µF +50% -20% 25V	26417-175
C108	Elec 1000µF +100% -20% 18V	26417-183
C109	Elec 500µF +100% -20% 15V	26417-173
C110	Elec 32µF +50% -20% 275V	26415-342
FL101	Mains filter	23642-901

FUSES

FS101	1A	23411-058
FS301	1A for 240V; 2A for 115V	23411-058
FS302	1A for 240V; 2A for 115V	23411-058

DIODES

MR1	Medium current	MIP 92003
MR2	Medium current	MIP 92003
MR3	Medium current	MIP 92003
MR4	Medium current	MIP 92003
MR5	Medium current	MIP 92003
MR6	Medium current	MIP 92003
MR7	Medium current	MIP 92003
MR8	Medium current	MIP 92003
MR9	Medium current	MIP 92003
MR10	Medium current	MIP 92003
MR11	Power rectifier	MIP 92002
MR12	High G	MIP 91004
MR13	20V Zener	MIP 90445
MR14	Medium current	MIP 92003
MR15	High current	MIP 92005
MR16	Medium current	MIP 92003
MR17	High current	MIP 92005
MR18	Medium current	MIP 92003
MR19	Medium current	MIP 92003
MR20	Medium current	MIP 92003
MR21	Medium current	MIP 92003
MR22	Medium current	MIP 92003
MR23	Medium current	MIP 92003
MR24	12V Zener	MIP 90441
MR25	Medium current	MIP 92003
MR26	Power rectifier	MIP 92002
MR27	Power rectifier	MIP 92002
MR101	General purpose	MIP 91005
MR102	High voltage	MIP 92004
MR103	Power rectifier	MIP 92002
MR104	Medium current	MIP 92003

PLP1	Lamp, 24V, 1W	23735-479
RV1	1kΩ ±10% $\frac{1}{4}$W/25°C	25886-195

RESISTORS

R1	Carb 15Ω ±5% 1/10W	24331-224
R2	Carb 33Ω ±10% 1/10W	24341-233
R3	Carb 2.2kΩ ±5% $\frac{1}{4}$W	24332-088
R4	Carb 2.2kΩ ±5% $\frac{1}{4}$W	24332-088
R5	Carb 1kΩ ±5% 1/10W	24331-280
R6	Carb 18kΩ ±5% 1/10W	24331-316
R7	Carb 6.8kΩ ±5% $\frac{1}{4}$W	24332-106
R8	Carb 6.8kΩ ±5% 1/10W	24331-306
R9	Carb 10kΩ ±5% 1/10W	24331-310
R12	Carb film 787Ω ±1% $\frac{1}{2}$W	24153-787
R13	Carb film 750Ω ±1% $\frac{1}{2}$W	24153-750
R15	WW 470Ω ±5% 1$\frac{1}{2}$W	25123-067
R16	Carb 10kΩ ±5% 1/10W	24331-310

For symbols and abbreviations see introduction to this section

Circuit reference	Description	M.I. code
R17	Carb 10kΩ ±5% 1/10W	24331-310
R18	Carb 5.6kΩ ±5% 1/10W	24331-303
R19	Carb 680Ω ±5% ¼W	24332-076
R20	Carb 5.6kΩ ±5% 1/10W	24331-303
R21	Carb 100Ω ±5% 1/10W	24331-250
R22	Carb film 249Ω ±1% ½W *	24153-249
R23	Carb film 787Ω ±1% ½W	24153-787
R24	Carb 220Ω ±5% 1/10W	24331-258
R25	Carb 2.2kΩ ±5% 1/10W	24331-288
R26	Carb 15kΩ ±5% 1/10W	24331-314
R27	Carb 1.5kΩ ±5% 1/10W	24331-284
R28	Carb 15Ω ±5% 1/10W	24331-224
R29	Carb 6.8kΩ ±5% 1/10W	24331-306
R30	Carb film 249Ω ±1% ½W	24153-249
R31	Carb film 499Ω ±1% ½W	24153-499
R32	Carb 5.6kΩ ±5% 1/10W	24331-303
R33	Carb 1.2kΩ ±5% ¼W	24332-082
R34	Carb 1kΩ ±5% ¼W	24332-080
R35	Carb 560Ω ±5% ¼W	24332-072
R37	Carb 220Ω ±5% ¼W	24332-058
R38	Carb 330Ω ±5% ¼W	24332-063
R39	Carb 1.5kΩ ±5% 1/10W	24331-284
R101	WW 0.2Ω ±10% 10W	24010-002
R102	WW 0.2Ω ±10% 10W	24010-002
R103	WW 0.5Ω ±10% 10W	24010-003
R104	WW 0.5Ω ±10% 10W	24010-003
R105	Carb 270Ω ±10% ¼W	24342-061
R106	Carb 100Ω ±10% ½W	24343-050
R107	Carb 68kΩ ±5% ½W	24333-131
R108	Carb 100Ω ±10% 1/10W	24341-250
R109	WW 360Ω ±5% 3½W	25125-629
R110	WW 360Ω ±5% 3½W	25125-629

SWITCHES

S101	Cut out	23010-015
S102	DPDT SUPPLY	23462-258

Circuit reference	Description	M.I. code
TRANSFORMERS		
T101	Standby	43452-006
T102	Mains	43461-020
TRANSISTORS		
VT1	General purpose	MIP 96501
VT2	High voltage	MIP 95509
VT3	High voltage	MIP 95514
VT4	General purpose	MIP 95008
VT5	Medium power	28434-937
VT6	Medium power	28434-937
VT7	Medium power	28434-937
VT8	General purpose	MIP 96501
VT9	General purpose	MIP 96501
VT10	General purpose	MIP 96501
VT11	High voltage	MIP 95514
VT12	High voltage	MIP 95014
VT13	General purpose	MIP 95008
VT14	General purpose	MIP 95012
VT15	General purpose	MIP 95012
VT16	General purpose	MIP 95012
VT101	Power transistor	MIP 95013
VT102	Power transistor	MIP 95013
VT103	Power transistor	MIP 95013
VT104	Power transistor	MIP 95018
VT105	Power transistor	MIP 95013

For symbols and abbreviations see introduction to this section

10 Mc/s D.C.U. with Memory and Readout: TM 7448

Circuit reference	Description	M.I. code
C1	Cer 36pF ±10% 500V	26383-166
C2	Cer 36pF ±10% 500V	26383-166
C3	Cer 36pF ±10% 500V	26383-166
C4	Cer 36pF ±10% 500V	26383-166
C5	Cer 36pF ±10% 500V	26383-166
C6	Cer 36pF ±10% 500V	26383-166
C7	Cer 36pF ±10% 500V	26383-166
C8	Cer 36pF ±10% 500V	26383-166
C9	Cer 36pF ±10% 500V	26383-166
C10	Cer 36pF ±10% 500V	26383-166
C11	Cer 36pF ±10% 500V	26383-166
C12	Cer 36pF ±10% 500V	26383-166
C13	Cer 36pF ±10% 500V	26383-166
C14	Cer 36pF ±10% 500V	26383-166
C15	Cer 36pF ±10% 500V	26383-166
C16	Cer 36pF ±10% 500V	26383-166
C17	Cer 0.1μF +50%-25% 12V	26383-029
C18	Cer 0.1μF +50%-25% 12V	26383-029

DIODES

MR1	General purpose	MIP 91003
MR2	Silicon planar	MIP 91006
MR3	General purpose	MIP 91003
MR4	Silicon planar	MIP 91006
MR5	General purpose	MIP 91003
MR6	Silicon planar	MIP 91006
MR7	General purpose	MIP 91003
MR8	Silicon planar	MIP 91006
MR9	General purpose	MIP 91003
MR10	General purpose	MIP 91003
MR11	General purpose	MIP 91003
MR12	General purpose	MIP 91003
MR13	General purpose	MIP 91003
MR14	General purpose	MIP 91003
MR15	General purpose	MIP 91003
MR16	General purpose	MIP 91003
MR17	Silicon planar	MIP 91006
MR18	Silicon planar	MIP 91006
MR19	Silicon planar	MIP 91006
MR20	Silicon planar	MIP 91006
MR21	General purpose	MIP 91003
MR22	General purpose	MIP 91003
MR23	General purpose	MIP 91003
MR24	Silicon planar	MIP 91006
MR25	Silicon planar	MIP 91006
MR26	General purpose	MIP 91003
MR27	General purpose	MIP 91003
MR28	General purpose	MIP 91003
MR29	General purpose	MIP 91003
MR30	General purpose	MIP 91003
MR31	General purpose	MIP 91003

RESISTORS

R1	Carb	510Ω ±5% 1/10W	24331-270
R2	Carb	12kΩ ±10% 1/10W	24341-312
R3	Carb	12kΩ ±10% 1/10W	24341-312
R4	Carb	510Ω ±5% 1/10W	24331-270
R5	Carb	680Ω ±10% 1/10W	24341-276
R6	Carb	12kΩ ±10% 1/10W	24341-312
R7	Carb	12kΩ ±10% 1/10W	24341-312
R8	Carb	680Ω ±10% 1/10W	24341-276
R9	Carb	680Ω ±10% 1/10W	24341-276
R10	Carb	12kΩ ±10% 1/10W	24341-312
R11	Carb	12kΩ ±10% 1/10W	24341-312
R12	Carb	680Ω ±10% 1/10W	24341-276
R13	Carb	680Ω ±10% 1/10W	24341-276
R14	Carb	12kΩ ±10% 1/10W	24341-312
R15	Carb	12kΩ ±10% 1/10W	24341-312
R16	Carb	680Ω ±10% 1/10W	24341-276

For symbols and abbreviations see introduction to this section

Circuit reference		Description	M.I. code	Circuit reference		Description	M.I. code
R17	Carb	2kΩ ±5% 1/10W	24331-287	R53	Carb	2kΩ ±5% 1/10W	24331-287
R18	Carb	2kΩ ±5% 1/10W	24331-287	R54	Carb	2kΩ ±5% 1/10W	24331-287
R19	Carb	3kΩ ±5% 1/10W	24331-293	R55	Carb	2kΩ ±5% 1/10W	24331-287
R20	Carb	3kΩ ±5% 1/10W	24331-293	R56	Carb	4.7kΩ ±10% 1/10W	24341-300
R21	Carb	3kΩ ±5% 1/10W	24331-293	R57	Carb	4.7kΩ ±10% 1/10W	24341-300
R22	Carb	3kΩ ±5% 1/10W	24331-293	R58	Carb	4.7kΩ ±10% 1/10W	24341-300
R23	Carb	3kΩ ±5% 1/10W	24331-293	R59	Carb	4.7kΩ ±10% 1/10W	24341-300
R24	Carb	3kΩ ±5% 1/10W	24331-293	R60	Carb	4.7kΩ ±10% 1/10W	24341-300
R25	Carb	2kΩ ±5% 1/10W	24331-287	R61	Carb	4.7kΩ ±10% 1/10W	24341-300
R26	Carb	2kΩ ±5% 1/10W	24331-287	R62	Carb	4.7kΩ ±10% 1/10W	24341-300
R27	Carb	2kΩ ±5% 1/10W	24331-287	R63	Carb	4.7kΩ ±10% 1/10W	24341-300
R28	Carb	2kΩ ±5% 1/10W	24331-287	R64	Carb	390Ω ±5% 1/10W	24331-265
R29	Carb	2kΩ ±5% 1/10W	24331-287	R65	Carb	390Ω ±5% 1/10W	24331-265
R30	Carb	2kΩ ±5% 1/10W	24331-287	R66	Carb	390Ω ±5% 1/10W	24331-265
R31	Carb	2kΩ ±5% 1/10W	24331-287	R67	Carb	390Ω ±5% 1/10W	24331-265
R32	Carb	2kΩ ±5% 1/10W	24331-287	R68	Carb	390Ω ±5% 1/10W	24331-265
R33	Carb	680Ω ±10% 1/10W	24341-276	R69	Carb	390Ω ±5% 1/10W	24331-265
R34	Carb	2kΩ ±5% 1/10W	24331-287	R70	Carb	390Ω ±5% 1/10W	24331-265
R35	Carb	20kΩ ±5% 1/10W	24331-317	R71	Carb	390Ω ±5% 1/10W	24331-265
R36	Carb	3.9kΩ ±10% 1/10W	24341-296	R72	Carb	2.2kΩ ±5% 1/10W	24331-288
R37	Carb	3.9kΩ ±10% 1/10W	24341-296	R73	Carb	2.2kΩ ±5% 1/10W	24331-288
R38	Carb	3.9kΩ ±10% 1/10W	24341-296	R74	Carb	2.2kΩ ±5% 1/10W	24331-288
R39	Carb	3.9kΩ ±10% 1/10W	24341-296	R75	Carb	2.2kΩ ±5% 1/10W	24331-288
R40	Carb	12kΩ ±10% 1/10W	24341-312	R76	Carb	2.2kΩ ±5% 1/10W	24331-288
R41	Carb	12kΩ ±10% 1/10W	24341-312	R77	Carb	2.2kΩ ±5% 1/10W	24331-288
R42	Carb	12kΩ ±10% 1/10W	24341-312	R78	Carb	2.2kΩ ±5% 1/10W	24331-288
R43	Carb	12kΩ ±10% 1/10W	24341-312	R79	Carb	2.2kΩ ±5% 1/10W	24331-288
R44	Carb	12kΩ ±10% 1/10W	24341-312	R80	Carb	27kΩ ±5% 1/10W	24331-320
R45	Carb	12kΩ ±10% 1/10W	24341-312	R81	Carb	27kΩ ±5% 1/10W	24331-320
R46	Carb	12kΩ ±10% 1/10W	24341-312	R82	Carb	3.9kΩ ±5% 1/10W	24331-296
R47	Carb	12kΩ ±10% 1/10W	24341-312	R83	Carb	27kΩ ±5% 1/10W	24331-320
R48	Carb	2kΩ ±5% 1/10W	24331-287	R84	Carb	27kΩ ±5% 1/10W	24331-320
R49	Carb	2kΩ ±5% 1/10W	24331-287	R85	Carb	3.9kΩ ±5% $\frac{1}{4}$W	24331-296
R50	Carb	2kΩ ±5% 1/10W	24331-287	R86	Carb	27kΩ ±5% 1/10W	24331-320
R51	Carb	2kΩ ±5% 1/10W	24331-287	R87	Carb	27kΩ ±5% 1/10W	24331-320
R52	Carb	2kΩ ±5% 1/10W	24331-287	R88	Carb	3.9kΩ ±5% 1/10W	24331-296

For symbols and abbreviations see introduction to this section

Circuit reference		Description	M.I. code
R89	Carb	27kΩ ±5% 1/10W	24331-320
R90	Carb	27kΩ ±5% 1/10W	24331-320
R91	Carb	3.9kΩ ±5% 1/10W	24331-296
R92	Carb	10kΩ ±5% 1/10W	24331-310
R93	Carb	10kΩ ±5% 1/10W	24331-310
R94	Carb	10kΩ ±5% 1/10W	24331-310
R95	Carb	10kΩ ±5% 1/10W	24331-310
R96	Carb	10kΩ ±5% 1/10W	24331-310
R97	Carb	10kΩ ±5% 1/10W	24331-310
R98	Carb	10kΩ ±5% 1/10W	24331-310
R99	Carb	10kΩ ±5% 1/10W	24331-310
R100	Carb	1.5kΩ ±5% 1/10W	24331-284
R101	Carb	10kΩ ±10% 1/10W	24341-310
R102	Carb	10kΩ ±10% 1/10W	24341-310
R103	Carb	10kΩ ±10% 1/10W	24341-310
R104	Carb	10kΩ ±10% 1/10W	24341-310
R105	Carb	10kΩ ±10% 1/10W	24341-310
R106	Carb	68kΩ ±10% ¼W	24342-131
R107	Carb	100kΩ ±10% 1/10W	24341-335
R108	Carb	100kΩ ±10% 1/10W	24341-335
R109	Carb	100kΩ ±10% 1/10W	24341-335
R110	Carb	100kΩ ±10% 1/10W	24341-335
R111	Carb	100kΩ ±10% 1/10W	24341-335
R112	Carb	100kΩ ±10% 1/10W	24341-335
R113	Carb	100kΩ ±10% 1/10W	24341-335
R114	Carb	100kΩ ±10% 1/10W	24341-335
R115	Carb	100kΩ ±10% 1/10W	24341-335
R116	Carb	100kΩ ±10% 1/10W	24341-335
R117	Carb	33kΩ ±10% ¼W	24342-122
R118	Carb	560Ω ±10% 1/10W	24341-272
R119	Carb	560Ω ±10% 1/10W	24341-272
R120	Carb	3.9kΩ ±10% 1/10W	24341-296
R121	Carb	3.9kΩ ±10% ¼W	24341-296
R122	Carb	3.9kΩ ±10% 1/10W	24341-296
R123	Carb	3.9kΩ ±10% 1/10W	24341-296

Circuit reference	Description	M.I. code
TRANSISTORS		
VT1	General purpose	MIP 95008
VT2	General purpose	MIP 95008
VT3	General purpose	MIP 95008
VT4	General purpose	MIP 95008
VT5	General purpose	MIP 95008
VT6	General purpose	MIP 95008
VT7	General purpose	MIP 95008
VT8	General purpose	MIP 95008
VT9	General purpose	MIP 95008
VT10	General purpose	MIP 95008
VT11	General purpose	MIP 95008
VT12	General purpose	MIP 95008
VT13	General purpose	MIP 95008
VT14	General purpose	MIP 95008
VT15	General purpose	MIP 95008
VT16	General purpose	MIP 95008
VT17	General purpose	MIP 95008
VT18	High speed epitaxial	MIP 95016
VT19	High speed epitaxial	MIP 95016
VT20	High speed epitaxial	MIP 95016
VT21	High speed epitaxial	MIP 95016
VT22	High speed epitaxial	MIP 95016
VT23	High speed epitaxial	MIP 95016
VT24	High speed epitaxial	MIP 95016
VT25	High speed epitaxial	MIP 95016
VT26	High voltage	MIP 95514
VT27	High voltage	MIP 95514
VT28	High voltage	MIP 95514
VT29	High voltage	MIP 95514
VT30	High voltage	MIP 95514
VT31	High voltage	MIP 95514
VT32	High voltage	MIP 95514
VT33	High voltage	MIP 95514
VT34	High voltage	MIP 95514
VT35	High voltage	MIP 95514

For symbols and abbreviations see introduction to this section

250 kc/s D.C.U. with Memory and Readout: TM 7449

Circuit reference	Description	M.I. code
CAPACITORS		
C1	Cer 220pF ±10% 500V	26383-205
C2	Cer 220pF ±10% 500V	26383-205
C3	Cer 220pF ±10% 500V	26383-205
C4	Cer 220pF ±10% 500V	26383-205
C5	Cer 220pF ±10% 500V	26383-205
C6	Cer 220pF ±10% 500V	26383-205
C7	Cer 220pF ±10% 500V	26383-205
C8	Cer 220pF ±10% 500V	26383-205
C9	Cer 470pF ±10% 500V	26383-222
C10	Cer 0.1μF +50% -25% 12V	26383-029
C11	Cer 470pF ±10% 500V	26383-222
C12	Cer 470pF ±10% 500V	26383-222
C13	Cer 470pF ±10% 500V	26383-222
C14	Cer 470pF ±10% 500V	26383-222
C15	Cer 470pF ±10% 500V	26383-222
C16	Cer 470pF ±10% 500V	26383-222
C17	Cer 470pF ±10% 500V	26383-222
C18	Cer 0.1μF +50% -25% 12V	26383-029
DIODES		
MR1	General purpose	MIP 91003
MR2	General purpose	MIP 91003
MR3	General purpose	MIP 91003
MR4	General purpose	MIP 91003
MR5	General purpose	MIP 91003
MR6	General purpose	MIP 91003
MR7	General purpose	MIP 91003
MR8	General purpose	MIP 91003
MR9	General purpose	MIP 91003
MR10	General purpose	MIP 91003
MR11	General purpose	MIP 91003
MR12	General purpose	MIP 91003
MR13	General purpose	MIP 91003
MR14	General purpose	MIP 91003
MR15	General purpose	MIP 91003
MR16	General purpose	MIP 91003
MR17	General purpose	MIP 91003
RESISTORS		
R1	Carb 510Ω ±5% 1/10W	24331-270
R2	Carb 12kΩ ±10% 1/10W	24341-312
R3	Carb 12kΩ ±10% 1/10W	24341-312
R4	Carb 510Ω ±5% 1/10W	24331-270
R5	Carb 680Ω ±10% 1/10W	24341-276
R6	Carb 12kΩ ±10% 1/10W	24341-312
R7	Carb 12kΩ ±10% 1/10W	24341-312
R8	Carb 680Ω ±10% 1/10W	24341-276
R9	Carb 680Ω ±10% 1/10W	24341-276
R10	Carb 12kΩ ±10% 1/10W	24341-312
R11	Carb 12kΩ ±10% 1/10W	24341-312
R13	Carb 680Ω ±10% 1/10W	24341-276
R14	Carb 680Ω ±10% 1/10W	24341-276
R15	Carb 12kΩ ±10% 1/10W	24341-312
R16	Carb 12kΩ ±10% 1/10W	24341-312
R17	Carb 680Ω ±10% 1/10W	24341-276
R18	Carb 2kΩ ±5% 1/10W	24331-287
R19	Carb 2kΩ ±5% 1/10W	24331-287
R20	Carb 3kΩ ±5% 1/10W	24331-293
R21	Carb 3kΩ ±5% 1/10W	24331-293
R22	Carb 3kΩ ±5% 1/10W	24331-293
R23	Carb 3kΩ ±5% 1/10W	24331-293
R24	Carb 3kΩ ±5% 1/10W	24331-293
R25	Carb 3kΩ ±5% 1/10W	24331-293

For symbols and abbreviations see introduction to this section

Circuit reference		Description	M.I. code	Circuit reference		Description	M.I. code
R26	Carb	680Ω ±10% 1/10W	24341-276	R63	Carb	3.9kΩ ±10% 1/10W	24341-296
R27	Carb	2kΩ ±5% 1/10W	24331-287	R64	Carb	3.9kΩ ±10% 1/10W	24341-296
R28	Carb	2kΩ ±5% 1/10W	24331-287	R65	Carb	3.9kΩ ±10% 1/10W	24341-296
R29	Carb	2kΩ ±5% 1/10W	24331-287	R66	Carb	470Ω ±10% 1/10W	24341-269
R30	Carb	2kΩ ±5% 1/10W	24331-287	R67	Carb	470Ω ±10% 1/10W	24341-269
R31	Carb	2kΩ ±5% 1/10W	24331-287	R68	Carb	3.9kΩ ±10% 1/10W	24341-296
R32	Carb	2kΩ ±5% 1/10W	24331-287	R69	Carb	470Ω ±10% 1/10W	24341-269
R33	Carb	2kΩ ±5% 1/10W	24331-287	R70	Carb	470Ω ±10% 1/10W	24341-269
R34	Carb	2kΩ ±5% 1/10W	24331-287	R71	Carb	3.9kΩ ±10% 1/10W	24341-296
R35	Carb	3.9kΩ ±10% 1/10W	24341-296	R72	Carb	470Ω ±10% 1/10W	24341-269
R36	Carb	2kΩ ±5% 1/10W	24331-287	R73	Carb	470Ω ±10% 1/10W	24341-269
R37	Carb	20kΩ ±5% 1/10W	24331-317	R74	Carb	3.9kΩ ±10% 1/10W	24341-296
R38	Carb	2kΩ ±5% 1/10W	24331-287	R75	Carb	470Ω ±10% 1/10W	24341-269
R39	Carb	3.9kΩ ±10% 1/10W	24341-296	R76	Carb	470Ω ±10% 1/10W	24341-269
R40	Carb	12kΩ ±10% 1/10W	24341-312	R77	Carb	4.3kΩ ±5% 1/10W	24331-298
R41	Carb	4.7kΩ ±10% 1/10W	24341-300	R78	Carb	4.3kΩ ±5% 1/10W	24331-298
R42	Carb	12kΩ ±10% 1/10W	24341-312	R79	Carb	4.3kΩ ±5% 1/10W	24331-298
R43	Carb	4.7kΩ ±10% 1/10W	24341-300	R80	Carb	4.3kΩ ±5% 1/10W	24331-298
R44	Carb	2kΩ ±5% 1/10W	24331-287	R81	Carb	4.3kΩ ±5% 1/10W	24331-298
R45	Carb	2kΩ ±5% 1/10W	24331-287	R82	Carb	4.3kΩ ±5% 1/10W	24331-298
R46	Carb	12kΩ ±10% 1/10W	24341-312	R83	Carb	4.3kΩ ±5% 1/10W	24331-298
R47	Carb	4.7kΩ ±10% 1/10W	24341-300	R84	Carb	4.3kΩ ±5% 1/10W	24331-298
R48	Carb	12kΩ ±10% 1/10W	24341-312	R85	Carb	20kΩ ±5% 1/10W	24331-317
R49	Carb	4.7kΩ ±10% 1/10W	24341-300	R86	Carb	20kΩ ±5% 1/10W	24331-317
R50	Carb	2kΩ ±5% 1/10W	24331-287	R87	Carb	3.9kΩ ±10% 1/10W	24341-296
R51	Carb	2kΩ ±5% 1/10W	24331-287	R89	Carb	20kΩ ±5% 1/10W	24331-317
R52	Carb	12kΩ ±10% 1/10W	24341-312	R90	Carb	20kΩ ±5% 1/10W	24331-317
R53	Carb	4.7kΩ ±10% 1/10W	24341-300	R91	Carb	3.9kΩ ±10% 1/10W	24341-296
R54	Carb	12kΩ ±10% 1/10W	24341-312	R92	Carb	20kΩ ±5% 1/10W	24331-317
R55	Carb	4.7kΩ ±10% 1/10W	24341-300	R93	Carb	20kΩ ±5% 1/10W	24331-317
R56	Carb	2kΩ ±5% 1/10W	24331-287	R94	Carb	3.9kΩ ±10% 1/10W	24341-296
R57	Carb	2kΩ ±5% 1/10W	24331-287	R95	Carb	20kΩ ±5% 1/10W	24331-317
R58	Carb	12kΩ ±10% 1/10W	24341-312	R96	Carb	20kΩ ±5% 1/10W	24331-317
R59	Carb	4.7kΩ ±10% 1/10W	24341-300	R97	Carb	3.9kΩ ±10% 1/10W	24341-296
R60	Carb	12kΩ ±10% 1/10W	24341-312	R98	Carb	10kΩ ±10% 1/10W	24341-310
R61	Carb	4.7kΩ ±10% 1/10W	24341-300	R99	Carb	10kΩ ±10% 1/10W	24341-310
R62	Carb	2kΩ ±5% 1/10W	24331-287	R100	Carb	2.2kΩ ±10% 1/10W	24341-288

For symbols and abbreviations see introduction to this section

Circuit reference		Description	M.I. code
R101	Carb	2.2kΩ ±10% 1/10W	24341-288
R102	Carb	2.2kΩ ±10% 1/10W	24341-288
R103	Carb	2.2kΩ ±10% 1/10W	24341-288
R104	Carb	2.2kΩ ±10% 1/10W	24341-288
R105	Carb	2.2kΩ ±10% 1/10W	24341-288
R106	Carb	100kΩ ±10% 1/10W	24341-335
R107	Carb	10kΩ ±10% 1/10W	24341-310
R108	Carb	100kΩ ±10% 1/10W	24341-335
R109	Carb	100kΩ ±10% 1/10W	24341-335
R110	Carb	10kΩ ±10% 1/10W	24341-310
R111	Carb	100kΩ ±10% 1/10W	24341-335
R112	Carb	100kΩ ±10% 1/10W	24341-335
R113	Carb	10kΩ ±10% 1/10W	24341-310
R114	Carb	100kΩ ±10% 1/10W	24341-335
R115	Carb	100kΩ ±10% 1/10W	24341-335
R116	Carb	10kΩ ±10% 1/10W	24341-310
R117	Carb	100kΩ ±10% 1/10W	24341-335
R118	Carb	100kΩ ±10% 1/10W	24341-335
R119	Carb	10kΩ ±10% 1/10W	24341-310
R120	Carb	100kΩ ±10% 1/10W	24341-335
R121	Carb	33kΩ ±10% ¼W	24342-122
R122	Carb	1.5kΩ ±10% 1/10W	24341-284
R123	Carb	68kΩ ±10% ¼W	24342-131
R124	Carb	560Ω ±10% 1/10W	24341-272
R125	Carb	560Ω ±10% 1/10W	24341-272

TRANSISTORS

Circuit reference	Description	M.I. code
VT1	General purpose	MIP 95008
VT2	General purpose	MIP 95008
VT3	General purpose	MIP 95008
VT4	General purpose	MIP 95008
VT5	General purpose	MIP 95008
VT6	General purpose	MIP 95008
VT7	General purpose	MIP 95008
VT8	General purpose	MIP 95008
VT9	General purpose	MIP 95008
VT10	General purpose	MIP 95008
VT11	General purpose	MIP 95008
VT12	General purpose	MIP 95008
VT13	General purpose	MIP 95008
VT14	General purpose	MIP 95008
VT15	General purpose	MIP 95008
VT16	General purpose	MIP 95008
VT17	General purpose	MIP 95008
VT18	General purpose	MIP 95008
VT19	General purpose	MIP 95008
VT20	General purpose	MIP 95008
VT21	General purpose	MIP 95008
VT22	General purpose	MIP 95008
VT23	General purpose	MIP 95008
VT24	General purpose	MIP 95008
VT25	General purpose	MIP 95008
VT26	High voltage	MIP 95514
VT27	High voltage	MIP 95514
VT28	High voltage	MIP 95514
VT29	High voltage	MIP 95514
VT30	High voltage	MIP 95514
VT31	High voltage	MIP 95514
VT32	High voltage	MIP 95514
VT33	High voltage	MIP 95514
VT34	High voltage	MIP 95514
VT35	High voltage	MIP 95514

10 Mc/s Dual Decade: TM 7450/1

CAPACITORS

Circuit reference		Description	M.I. code
C1	Cer	36pF ±10% 500V	26383-166
C2	Cer	36pF ±10% 500V	26383-166
C3	Cer	36pF ±10% 500V	26383-166

For symbols and abbreviations see introduction to this section

Circuit reference		Description	M.I. code
C4	Cer	36pF ±10% 500V	26383-166
C5	Cer	36pF ±10% 500V	26383-166
C6	Cer	36pF ±10% 500V	26383-166
C7	Cer	36pF ±10% 500V	26383-166
C8	Cer	36pF ±10% 500V	26383-166
C9	Cer	36pF ±10% 500V	26383-166
C10	Cer	36pF ±10% 500V	26383-166
C11	Cer	36pF ±10% 500V	26383-166
C12	Cer	36pF ±10% 500V	26383-166
C13	Cer	36pF ±10% 500V	26383-166
C14	Cer	36pF ±10% 500V	26383-166
C15	Cer	36pF ±10% 500V	26383-166
C16	Cer	36pF ±10% 500V	26383-166
C17	Cer	0.1μF +80% -20% 12V	26382-214
C18	Cer	0.1μF +80% -20% 12V	26382-214
C19	Cer	220pF ±10% 500V	26383-205
C20	Cer	15pF ±10% 500V	26343-346
C21	Cer	0.1μF +80% -20% 12V	26382-214
C23	Cer	33pF ±10% 500V	26383-163
C24	Cer	36pF ±10% 500V	26383-166
C25	Cer	36pF ±10% 500V	26383-166
C26	Cer	36pF ±10% 500V	26383-166
C27	Cer	36pF ±10% 500V	26383-166
C28	Cer	36pF ±10% 500V	26383-166
C29	Cer	36pF ±10% 500V	26383-166
C30	Cer	36pF ±10% 500V	26383-166
C31	Cer	36pF ±10% 500V	26383-166
C32	Cer	36pF ±10% 500V	26383-166
C33	Cer	36pF ±10% 500V	26383-166
C34	Cer	36pF ±10% 500V	26383-166
C35	Cer	36pF ±10% 500V	26383-166
C36	Cer	36pF ±10% 500V	26383-166
C37	Cer	36pF ±10% 500V	26383-166
C38	Cer	36pF ±10% 500V	26383-166
C39	Cer	36pF ±10% 500V	26383-166
C40	Cer	0.1μF +80% -20% 12V	26382-216
C48	Cer	10pF ±10% 500V	26343-338
C49	Cer	36pF ±10% 500V	26383-166
C50	Cer	15pF ±10% 500V	26343-346
C51	Cer	36pF ±10% 500V	26383-166
C52	Cer	36pF ±10% 500V	26383-166
C53	Cer	36pF ±10% 500V	26383-166
C54	Cer	680pF ±10% 500V	26383-232
C60	Cer	0.1μF +50% -25% 25V	26383-031
DIODES			
MR1		General purpose	MIP 91003
MR2		General purpose	MIP 91003
MR3		Silicon planar	MIP 91006
MR4		Silicon planar	MIP 91006
MR5		Silicon planar	MIP 91006
MR6		Silicon planar	MIP 91006
MR7		Silicon planar	MIP 91006
MR8		Silicon planar	MIP 91006
MR9		General purpose	MIP 91003
MR10		General purpose	MIP 91003
MR11		Silicon planar	MIP 91006
MR12		Silicon planar	MIP 91006
MR13		Silicon planar	MIP 91006
MR14		Silicon planar	MIP 91006
MR15		General purpose	MIP 91003
MR16		General purpose	MIP 91003
MR17		General purpose	MIP 91003
MR18		General purpose	MIP 91003
MR19		General purpose	MIP 91003
MR20		General purpose	MIP 91003

For symbols and abbreviations see introduction to this section

Circuit reference	Description	M.I. code
MR22	General purpose	MIP 91003
MR23	General purpose	MIP 91003
MR24	General purpose	MIP 91003
MR25	General purpose	MIP 91003
MR26	General purpose	MIP 91003
MR27	General purpose	MIP 91003
MR28	Silicon planar	MIP 91006
MR29	High G	MIP 91004
MR30	General purpose	MIP 91003
MR31	General purpose	MIP 91003
MR32	General purpose	MIP 91003
MR33	General purpose	MIP 91003
MR34	General purpose	MIP 91003
MR35	General purpose	MIP 91003
MR36	General purpose	MIP 91003
MR37	General purpose	MIP 91003
MR38	General purpose	MIP 91003
MR39	General purpose	MIP 91003
MR40	General purpose	MIP 91003
MR41	General purpose	MIP 91003
MR42	General purpose	MIP 91003
MR43	General purpose	MIP 91003
MR44	General purpose	MIP 91003
MR45	General purpose	MIP 91003
MR46	General purpose	MIP 91003
MR47	General purpose	MIP 91003
MR48	General purpose	MIP 91003
MR49	General purpose	MIP 91003
MR50	General purpose	MIP 91003
MR52	General purpose	MIP 91003
MR53	General purpose	MIP 91003
MR54	General purpose	MIP 91003
MR55	General purpose	MIP 91003
MR56	General purpose	MIP 91003
MR57	General purpose	MIP 91003
MR58	High G	MIP 91004
MR59	General purpose	MIP 91003
MR60	General purpose	MIP 91003
MR61	High G	MIP 91004
MR62	High G	MIP 91004
MR63	General purpose	MIP 91003
MR64	General purpose	MIP 91003
MR65	General purpose	MIP 91003
MR66	General purpose	MIP 91003
MR67	General purpose	MIP 91003
MR68	General purpose	MIP 91003
MR69	General purpose	MIP 91003
MR70	General purpose	MIP 91003
MR71	General purpose	MIP 91003
MR72	General purpose	MIP 91003
MR73	General purpose	MIP 91003
MR74	General purpose	MIP 91003
MR75	General purpose	MIP 91003
MR76	General purpose	MIP 91003
MR77	General purpose	MIP 91003
MR78	General purpose	MIP 91003
MR79	High G	MIP 91004
MR81	Silicon planar	MIP 91006
MR83	Silicon planar	MIP 91006
MR85	General purpose	MIP 91003
MR86	Fast switching, high G	MIP 91007
MR87	Silicon planar	MIP 91006
MR88	Silicon planar	MIP 91006

RESISTORS

R1	Carb	390Ω ±5% 1/10W	24331-265
R2	Carb	390Ω ±5% 1/10W	24331-265
R3	Carb	2.2kΩ ±5% 1/10W	24331-288
R4	Carb	2.2kΩ ±5% 1/10W	24331-288
R5	Carb	3.9kΩ ±5% 1/10W	24331-296

For symbols and abbreviations see introduction to this section

Circuit reference		Description	M.I. code
R6	Carb	27kΩ ±5% 1/10W	24331-320
R7	Carb	27kΩ ±5% 1/10W	24331-320
R8	Carb	10kΩ ±5% 1/10W	24331-310
R9	Carb	10kΩ ±5% 1/10W	24331-310
R10	Carb	390Ω ±5% 1/10W	24331-265
R11	Carb	390Ω ±5% 1/10W	24331-265
R12	Carb	2.2kΩ ±5% 1/10W	24331-288
R13	Carb	2.2kΩ ±5% 1/10W	24331-288
R14	Carb	27kΩ ±5% 1/10W	24331-320
R15	Carb	27kΩ ±5% 1/10W	24331-320
R16	Carb	3.9kΩ ±5% 1/10W	24331-296
R17	Carb	10kΩ ±5% 1/10W	24331-310
R18	Carb	10kΩ ±5% 1/10W	24331-310
R19	Carb	1.5kΩ ±5% 1/10W	24331-284
R20	Carb	390Ω ±5% 1/10W	24331-265
R21	Carb	390Ω ±5% 1/10W	24331-265
R22	Carb	2.2kΩ ±5% 1/10W	24331-288
R23	Carb	2.2kΩ ±5% 1/10W	24331-288
R24	Carb	27kΩ ±5% 1/10W	24331-320
R25	Carb	27kΩ ±5% 1/10W	24331-320
R26	Carb	3.9kΩ ±5% 1/10W	24331-296
R27	Carb	10kΩ ±5% 1/10W	24331-310
R28	Carb	10kΩ ±5% 1/10W	24331-310
R29	Carb	390Ω ±5% 1/10W	24331-265
R30	Carb	390Ω ±5% 1/10W	24331-265
R31	Carb	2.2kΩ ±5% 1/10W	24331-288
R32	Carb	2.2kΩ ±5% 1/10W	24331-288
R33	Carb	3.9kΩ ±5% 1/10W	24331-296
R34	Carb	27kΩ ±5% 1/10W	24331-320
R35	Carb	27kΩ ±5% 1/10W	24331-320
R36	Carb	10kΩ ±5% 1/10W	24331-310
R37	Carb	10kΩ ±5% 1/10W	24331-310
R38	Carb	100kΩ ±5% 1/10W	24331-335
R40	Carb	270Ω ±5% ¼W	24332-661
R41	Carb	560Ω ±5% 1/10W	24331-272
R42	Carb	6.2kΩ ±5% 1/10W	24331-304
R44	Carb	270Ω ±5% ¼W	24332-661
R46	Carb	1kΩ ±5% 1/10W	24331-280
R49	Carb	270Ω ±5% ¼W	24332-661
R50	Carb	6.2kΩ ±5% 1/10W	24331-304
R53	Carb	1kΩ ±5% 1/10W	24331-280
R54	Carb	10kΩ ±5% 1/10W	24331-310
R55	Carb	390Ω ±5% 1/10W	24331-265
R56	Carb	390Ω ±5% 1/10W	24331-265
R57	Carb	2.2kΩ ±5% 1/10W	24331-288
R58	Carb	2.2kΩ ±5% 1/10W	24331-288
R59	Carb	3.9kΩ ±5% 1/10W	24331-296
R60	Carb	27kΩ ±5% 1/10W	24331-320
R61	Carb	27kΩ ±5% 1/10W	24331-320
R62	Carb	10kΩ ±5% 1/10W	24331-310
R63	Carb	10kΩ ±5% 1/10W	24331-310
R64	Carb	390Ω ±5% 1/10W	24331-265
R65	Carb	390Ω ±5% 1/10W	24331-265
R66	Carb	2.2kΩ ±5% 1/10W	24331-288
R67	Carb	2.2kΩ ±5% 1/10W	24331-288
R68	Carb	27kΩ ±5% 1/10W	24331-320
R69	Carb	27kΩ ±5% 1/10W	24331-320
R70	Carb	3.9kΩ ±5% 1/10W	24331-296
R71	Carb	10kΩ ±5% 1/10W	24331-310
R72	Carb	10kΩ ±5% 1/10W	24331-310
R73	Carb	1.5kΩ ±5% 1/10W	24331-284
R74	Carb	390Ω ±5% 1/10W	24331-265
R75	Carb	390Ω ±5% 1/10W	24331-265
R76	Carb	2.2kΩ ±5% 1/10W	24331-288
R77	Carb	2.2kΩ ±5% 1/10W	24331-288
R78	Carb	27kΩ ±5% 1/10W	24331-320
R79	Carb	27kΩ ±5% 1/10W	24331-320
R80	Carb	3.9kΩ ±5% 1/10W	24331-296
R81	Carb	10kΩ ±5% 1/10W	24331-310
R82	Carb	10kΩ ±5% 1/10W	24331-310
R83	Carb	390Ω ±5% 1/10W	24331-265

For symbols and abbreviations see introduction to this section

Circuit reference		Description	M.I. code
R84	Carb	390Ω ±5% 1/10W	24331-265
R85	Carb	2.2kΩ ±5% 1/10W	24331-288
R86	Carb	2.2kΩ ±5% 1/10W	24331-288
R87	Carb	3.9kΩ ±5% 1/10W	24331-296
R88	Carb	27kΩ ±5% 1/10W	24331-320
R89	Carb	27kΩ ±5% 1/10W	24331-320
R90	Carb	10kΩ ±5% 1/10W	24331-310
R91	Carb	10kΩ ±5% 1/10W	24331-310
R92	Carb	560Ω ±5% 1/10W	24331-272
R93	Carb	1kΩ ±5% 1/10W	24331-280
R95	Carb	12kΩ ±5% 1/10W	24331-312
R96	Carb	560Ω ±5% 1/10W	24331-272
R97	Carb	1kΩ ±5% 1/10W	24331-280
R99	Carb	12kΩ ±5% 1/10W	24331-312
R100	Carb	560Ω ±5% 1/10W	24331-272
R101	Carb	1kΩ ±5% 1/10W	24331-280
R103	Carb	12kΩ ±5% 1/10W	24331-312
R104	Carb	560Ω ±5% 1/10W	24331-272
R106	Carb	1kΩ ±5% 1/10W	24331-280
R107	Carb	12kΩ ±5% 1/10W	24331-312
R108	Carb	560Ω ±5% 1/10W	24331-272
R110	Carb	1kΩ ±5% 1/10W	24331-280
R111	Carb	12kΩ ±5% 1/10W	24331-312
R112	Carb	560Ω ±5% 1/10W	24331-272
R114	Carb	1kΩ ±5% 1/10W	24331-280
R115	Carb	12kΩ ±5% 1/10W	24331-312
R116	Carb	2.7kΩ ±5% 1/10W	24331-292
R117	Carb	10kΩ ±5% 1/10W	24331-310
R118	Carb	330Ω ±5% ¼W	24332-663
R119	Carb	5.6kΩ ±5% 1/10W	24331-303
R120	Carb	39kΩ ±5% 1/10W	24331-324
R121	Carb	1kΩ ±5% ¼W	24332-080
R122	Carb	10kΩ ±5% 1/10W	24331-310
R124	Carb	1kΩ ±5% 1/10W	24331-280
R125	Carb	300Ω ±5% ¼W	24332-662
R126	Carb	10kΩ ±5% 1/10W	24331-310
R127	Carb	75Ω ±5% ¼W	24332-644
R128	Carb	680Ω ±5% 1/10W	24331-276
R129	Carb	390Ω ±5% 1/10W	24331-265
R130	Carb	2.2kΩ ±5% 1/10W	24331-288
R131	Carb	2.2kΩ ±5% 1/10W	24331-288
R133	Carb	10kΩ ±5% 1/10W	24331-310
R134	Carb	27kΩ ±5% 1/10W	24331-320
R135	Carb	27kΩ ±5% 1/10W	24331-320
R137	Carb	680Ω ±5% 1/10W	24331-276
R138	Carb	1kΩ ±5% 1/10W	24331-280
R139	Carb	3.9kΩ ±5% 1/10W	24331-296
R140	Carb	3.9kΩ ±5% 1/10W	24331-296
R141	Carb	1kΩ ±5% 1/10W	24331-280

TRANSISTORS

VT1	High speed epitaxial	MIP 95016
VT2	High speed epitaxial	MIP 95016
VT3	High speed epitaxial	MIP 95016
VT4	High speed epitaxial	MIP 95016
VT5	High speed epitaxial	MIP 95016
VT6	High speed epitaxial	MIP 95016
VT7	High speed epitaxial	MIP 95016
VT8	High speed epitaxial	MIP 95016
VT9	High speed epitaxial	MIP 95010
VT10	High speed epitaxial	MIP 95010
VT11	Silicon planar	28452-787
VT12	High speed epitaxial	MIP 95016
VT13	General purpose	MIP 95008
VT14	High speed epitaxial	MIP 95016
VT15	High speed epitaxial	MIP 95016
VT16	High speed epitaxial	MIP 95016

For symbols and abbreviations see introduction to this section

Circuit reference	Description	M.I. code
VT17	High speed epitaxial	MIP 95016
VT18	High speed epitaxial	MIP 95016
VT19	High speed epitaxial	MIP 95016
VT20	High speed epitaxial	MIP 95016
VT21	High speed epitaxial	MIP 95016
VT22	High speed epitaxial	MIP 95010
VT23	General purpose	MIP 95008
VT24	General purpose	MIP 95008
VT25	General purpose	MIP 95008
VT26	General purpose	MIP 95008
VT27	General purpose	MIP 95008
VT28	High speed epitaxial	MIP 95010
VT29	High speed epitaxial	MIP 95010
VT30	High speed epitaxial	MIP 95016
VT31	High speed epitaxial	MIP 95016

250 kc/s Dual Decade: TM 7451

CAPACITORS

C1	Cer	220pF ±10% 500V	26383-205
C2	Cer	220pF ±10% 500V	26383-205
C3	Cer	220pF ±10% 500V	26383-205
C4	Cer	220pF ±10% 500V	26383-205
C5	Cer	220pF ±10% 500V	26383-205
C6	Cer	220pF ±10% 500V	26383-205
C7	Cer	220pF ±10% 500V	26383-205
C8	Cer	220pF ±10% 500V	26383-205
C9	Cer	470pF ±10% 500V	26383-222
C10	Cer	470pF ±10% 500V	26383-222
C11	Cer	470pF ±10% 500V	26383-222
C12	Cer	470pF ±10% 500V	26383-222
C13	Cer	470pF ±10% 500V	26383-222
C14	Cer	470pF ±10% 500V	26383-222
C15	Cer	470pF ±10% 500V	26383-222
C16	Cer	470pF ±10% 500V	26383-222
C17	Cer	0.1μF +50% -25% 12V	26383-029
C18	Cer	0.1μF +50% -25% 12V	26383-029
C19	Cer	220pF ±10% 500V	26383-205
C20	Cer	220pF ±10% 500V	26383-205
C21	Cer	220pF ±10% 500V	26383-205
C22	Cer	220pF ±10% 500V	26383-205
C23	Cer	220pF ±10% 500V	26383-205
C24	Cer	220pF ±10% 500V	26383-205
C25	Cer	220pF ±10% 500V	26383-205
C26	Cer	220pF ±10% 500V	26383-205
C27	Cer	220pF ±10% 500V	26383-205
C28	Cer	220pF ±10% 500V	26383-205
C29	Cer	220pF ±10% 500V	26383-205
C30	Cer	470pF ±10% 500V	26383-222
C31	Cer	470pF ±10% 500V	26383-222
C32	Cer	470pF ±10% 500V	26383-222
C33	Cer	470pF ±10% 500V	26383-222
C34	Cer	470pF ±10% 500V	26383-222
C35	Cer	470pF ±10% 500V	26383-222
C36	Cer	470pF ±10% 500V	26383-222
C37	Cer	470pF ±10% 500V	26383-222
C38	Cer	0.1μF +50% -25% 12V	26383-029
C39	Cer	0.1μF +50% -25% 12V	26383-029
C40	Cer	220pF ±10% 500V	26383-205
C41	Cer	220pF ±10% 500V	26383-205
C42	Cer	220pF ±10% 500V	26383-205

DIODES

MR1	General purpose	MIP 91003
MR2	General purpose	MIP 91003
MR3	General purpose	MIP 91003
MR4	General purpose	MIP 91003
MR5	General purpose	MIP 91003

For symbols and abbreviations see introduction to this section

Circuit reference	Description	M.I. code
MR6	General purpose	MIP 91003
MR7	General purpose	MIP 91003
MR8	General purpose	MIP 91003
MR9	General purpose	MIP 91003
MR10	General purpose	MIP 91003
MR11	General purpose	MIP 91003
MR12	General purpose	MIP 91003
MR13	General purpose	MIP 91003
MR14	General purpose	MIP 91003
MR15	General purpose	MIP 91003
MR16	General purpose	MIP 91003
MR17	General purpose	MIP 91003
MR18	General purpose	MIP 91003
MR19	General purpose	MIP 91003
MR20	General purpose	MIP 91003
MR21	General purpose	MIP 91003
MR22	General purpose	MIP 91003
MR23	General purpose	MIP 91003
MR24	General purpose	MIP 91003
MR25	General purpose	MIP 91003
MR26	General purpose	MIP 91003
MR27	General purpose	MIP 91003
MR28	General purpose	MIP 91003

RESISTORS

Circuit reference	Description	M.I. code
R1	Carb 470Ω ±10% 1/10W	24341-269
R2	Carb 470Ω ±10% 1/10W	24341-269
R3	Carb 470Ω ±10% 1/10W	24341-269
R4	Carb 470Ω ±10% 1/10W	24341-269
R5	Carb 470Ω ±10% 1/10W	24341-269
R6	Carb 470Ω ±10% 1/10W	24341-269
R7	Carb 2.7kΩ ±10% 1/10W	24341-292
R8	Carb 1.2kΩ ±10% 1/10W	24341-282
R9	Carb 470Ω ±10% 1/10W	24341-269
R10	Carb 560Ω ±10% 1/10W	24341-272
R11	Carb 4.3kΩ ±5% 1/10W	24331-298
R12	Carb 4.3kΩ ±5% 1/10W	24331-298
R13	Carb 4.3kΩ ±5% 1/10W	24331-298
R14	Carb 4.3kΩ ±5% 1/10W	24331-298
R15	Carb 4.3kΩ ±5% 1/10W	24331-298
R16	Carb 4.3kΩ ±5% 1/10W	24331-298
R17	Carb 4.7kΩ ±10% 1/10W	24341-300
R18	Carb 4.3kΩ ±5% 1/10W	24331-298
R19	Carb 3.9kΩ ±10% 1/10W	24341-296
R20	Carb 3.9kΩ ±10% 1/10W	24341-296
R21	Carb 560Ω ±10% 1/10W	24341-272
R22	Carb 3.9kΩ ±10% 1/10W	24341-296
R23	Carb 560Ω ±10% 1/10W	24341-272
R24	Carb 2kΩ ±5% 1/10W	24331-287
R25	Carb 2kΩ ±5% 1/10W	24331-287
R26	Carb 2kΩ ±5% 1/10W	24331-287
R27	Carb 3.9kΩ ±10% 1/10W	24341-296
R28	Carb 20kΩ ±5% 1/10W	24331-317
R29	Carb 20kΩ ±5% 1/10W	24331-317
R30	Carb 20kΩ ±5% 1/10W	24331-317
R31	Carb 20kΩ ±5% 1/10W	24331-317
R32	Carb 3.9kΩ ±10% 1/10W	24341-296
R33	Carb 20kΩ ±5% 1/10W	24331-317
R34	Carb 20kΩ ±5% 1/10W	24331-317
R35	Carb 3.9kΩ ±10% 1/10W	24341-296
R36	Carb 3.9kΩ ±10% 1/10W	24341-296
R37	Carb 20kΩ ±5% 1/10W	24331-317
R38	Carb 20kΩ ±5% 1/10W	24331-317
R39	Carb 10kΩ ±10% 1/10W	24341-310
R40	Carb 10kΩ ±10% 1/10W	24341-310
R41	Carb 10kΩ ±10% 1/10W	24341-310
R42	Carb 2.2kΩ ±10% 1/10W	24341-288
R43	Carb 2.2kΩ ±10% 1/10W	24341-288

For symbols and abbreviations see introduction to this section

Circuit reference		Description	M.I. code
R44	Carb	2.2kΩ ±10% 1/10W	24341-288
R45	Carb	2.2kΩ ±10% 1/10W	24341-288
R46	Carb	2.2kΩ ±10% 1/10W	24341-288
R47	Carb	2.2kΩ ±10% 1/10W	24341-288
R48	Carb	2.2kΩ ±10% 1/10W	24341-288
R49	Carb	2.2kΩ ±10% 1/10W	24341-288
R50	Carb	470Ω ±10% 1/10W	24341-269
R51	Carb	470Ω ±10% 1/10W	24341-269
R52	Carb	470Ω ±10% 1/10W	24341-269
R53	Carb	470Ω ±10% 1/10W	24341-269
R54	Carb	470Ω ±10% 1/10W	24341-269
R55	Carb	470Ω ±10% 1/10W	24341-269
R56	Carb	2.7kΩ ±10% 1/10W	24341-292
R57	Carb	1.2kΩ ±10% 1/10W	24341-282
R58	Carb	470Ω ±10% 1/10W	24341-269
R59	Carb	4.3kΩ ±5% 1/10W	24331-298
R60	Carb	4.3kΩ ±5% 1/10W	24331-298
R61	Carb	4.3kΩ ±5% 1/10W	24331-298
R62	Carb	4.3kΩ ±5% 1/10W	24331-298
R63	Carb	4.3kΩ ±5% 1/10W	24331-298
R64	Carb	4.3kΩ ±5% 1/10W	24331-298
R65	Carb	4.7kΩ ±10% 1/10W	24341-300
R66	Carb	4.3kΩ ±5% 1/10W	24331-298
R67	Carb	3.9kΩ ±10% 1/10W	24341-296
R68	Carb	560Ω ±10% 1/10W	24341-272
R69	Carb	3.9kΩ ±10% 1/10W	24341-296
R70	Carb	560Ω ±10% 1/10W	24341-272
R71	Carb	3.9kΩ ±10% 1/10W	24341-296
R72	Carb	560Ω ±10% 1/10W	24341-272
R73	Carb	3.9kΩ ±10% 1/10W	24341-296
R74	Carb	20kΩ ±5% 1/10W	24331-317
R75	Carb	20kΩ ±5% 1/10W	24331-317
R76	Carb	20kΩ ±5% 1/10W	24331-317
R77	Carb	20kΩ ±5% 1/10W	24331-317
R78	Carb	3.9kΩ ±10% 1/10W	24341-296
R79	Carb	20kΩ ±5% 1/10W	24331-317
R80	Carb	20kΩ ±5% 1/10W	24331-317
R81	Carb	3.9kΩ ±10% 1/10W	24341-296
R82	Carb	3.9kΩ ±10% 1/10W	24341-296
R83	Carb	20kΩ ±5% 1/10W	24331-317
R84	Carb	20kΩ ±5% 1/10W	24331-317
R85	Carb	2kΩ ±5% 1/10W	24331-287
R86	Carb	10kΩ ±10% 1/10W	24341-310
R87	Carb	2kΩ ±5% 1/10W	24331-287
R88	Carb	10kΩ ±10% 1/10W	24341-310
R89	Carb	2kΩ ±5% 1/10W	24331-287
R90	Carb	10kΩ ±10% 1/10W	24341-310
R91	Carb	2.2kΩ ±10% 1/10W	24341-288
R92	Carb	2.2kΩ ±10% 1/10W	24341-288
R93	Carb	2.2kΩ ±10% 1/10W	24341-288
R94	Carb	2.2kΩ ±10% 1/10W	24341-288
R95	Carb	2.2kΩ ±10% 1/10W	24341-288
R96	Carb	2.2kΩ ±10% 1/10W	24341-288
R97	Carb	2.2kΩ ±10% 1/10W	24341-288
R98	Carb	2.2kΩ ±10% 1/10W	24341-288

TRANSISTORS

VT1	General purpose	MIP 95008
VT2	General purpose	MIP 95008
VT3	General purpose	MIP 95008
VT4	General purpose	MIP 95008
VT5	General purpose	MIP 95008
VT6	General purpose	MIP 95008
VT7	General purpose	MIP 95008
VT8	General purpose	MIP 95008
VT9	General purpose	MIP 95008
VT10	General purpose	MIP 95008
VT11	General purpose	MIP 95008
VT12	General purpose	MIP 95008

For symbols and abbreviations see introduction to this section

Circuit reference	Description	M.I. code
VT13	General purpose	MIP 95008
VT14	General purpose	MIP 95008
VT15	General purpose	MIP 95008
VT16	General purpose	MIP 95008
VT17	General purpose	MIP 95008
VT18	General purpose	MIP 95008
VT19	General purpose	MIP 95008
VT20	General purpose	MIP 95008
VT21	General purpose	MIP 95008
VT22	General purpose	MIP 95008
MR9	General purpose	MIP 91005
MR10	General purpose	MIP 91005
MR11	High G	MIP 91004
MR12	General purpose	MIP 91003
MR13	General purpose	MIP 91003
MR14	General purpose	MIP 91003
MR15	General purpose	MIP 91003
MR16	General purpose	MIP 91003
MR17	General purpose	MIP 91003
MR18	Medium current	MIP 92003

Display Control, Reset and Memory: TM 7447

CAPACITORS

C1	Cer	0.003μF ±25% 300V	26383-295
C2	Cer	100pF ±10% 500V	26383-106
C3	Cer	390pF ±10% 500V	26383-217
C4	Elec	120μF ±20% 10V	26488-236
C5	Cer	0.005μF ±25% 300V	26383-375
C6	Cer	680pF ±10% 500V	26383-232
C7	Cer	0.1μF +50% -25% 12V	26383-029
C8	Cer	0.1μF +50% -25% 12V	26383-029

DIODES

MR2	High G	MIP 91004
MR3	General purpose	MIP 91003
MR4	General purpose	MIP 91005
MR5	General purpose	MIP 91003
MR6	SCR	MIP 97002
MR7	General purpose	MIP 91005
MR8	Medium current	MIP 92003

RESISTORS

R1	Carb	510Ω ±5% 1/10W	24331-270
R2	Carb	2kΩ ±5% 1/10W	24331-287
R3	Carb	12kΩ ±10% 1/10W	24341-312
R4	Carb	12kΩ ±10% 1/10W	24341-312
R5	Carb	2kΩ ±5% 1/10W	24331-287
R6	Carb	510Ω ±5% 1/10W	24331-270
R7	Carb	680Ω ±10% 1/10W	24341-276
R8	Carb	3kΩ ±5% 1/10W	24331-293
R9	Carb	12kΩ ±10% 1/10W	24341-312
R10	Carb	12kΩ ±10% 1/10W	24341-312
R11	Carb	3kΩ ±5% 1/10W	24331-293
R12	Carb	680Ω ±10% 1/10W	24341-276
R13	Carb	680Ω ±10% 1/10W	24341-276
R14	Carb	3kΩ ±5% 1/10W	24331-293
R15	Carb	12kΩ ±10% 1/10W	24341-312
R16	Carb	12kΩ ±10% 1/10W	24341-312
R17	Carb	3kΩ ±5% 1/10W	24331-293
R18	Carb	680Ω ±10% 1/10W	24341-276
R19	Carb	680Ω ±10% 1/10W	24341-276
R20	Carb	3kΩ ±5% 1/10W	24331-293
R21	Carb	12kΩ ±10% 1/10W	24341-312
R22	Carb	12kΩ ±10% 1/10W	24341-312

For symbols and abbreviations see introduction to this section

Circuit reference		Description	M.I. code
R23	Carb	3kΩ ±5% 1/10W	24331-293
R24	Carb	680Ω ±10% 1/10W	24341-276
R25	Carb	680Ω ±10% 1/10W	24341-276
R26	Carb	2kΩ ±5% 1/10W	24331-287
R27	Carb	2kΩ ±5% 1/10W	24331-287
R28	Carb	2kΩ ±5% 1/10W	24331-287
R29	Carb	2kΩ ±5% 1/10W	24331-287
R30	Carb	2kΩ ±5% 1/10W	24331-287
R31	Carb	2kΩ ±5% 1/10W	24331-287
R32	Carb	2kΩ ±5% 1/10W	24331-287
R33	Carb	2kΩ ±5% 1/10W	24331-287
R34	Carb	2kΩ ±5% 1/10W	24331-287
R35	Carb	12kΩ ±10% 1/10W	24341-312
R36	Carb	2kΩ ±5% 1/10W	24331-287
R37	Carb	3.9kΩ ±10% 1/10W	24341-296
R38	Carb	12kΩ ±10% 1/10W	24341-312
R39	Carb	2kΩ ±5% 1/10W	24331-287
R40	Carb	12kΩ ±10% 1/10W	24341-312
R41	Carb	4.7kΩ ±10% 1/10W	24341-300
R42	Carb	1kΩ ±10% 1/10W	24341-280
R43	Carb	2kΩ ±5% 1/10W	24331-287
R44	Carb	12kΩ ±10% 1/10W	24341-312
R45	Carb	2kΩ ±5% 1/10W	24331-287
R46	Carb	12kΩ ±10% 1/10W	24341-312
R47	Carb	4.7kΩ ±10% 1/10W	24341-300
R48	Carb	1kΩ ±10% 1/10W	24341-280
R49	Carb	2kΩ ±5% 1/10W	24331-287
R50	Carb	12kΩ ±10% 1/10W	24341-312
R51	Carb	2kΩ ±5% 1/10W	24331-287
R52	Carb	12kΩ ±10% 1/10W	24341-312
R53	Carb	4.7kΩ ±10% 1/10W	24341-300
R54	Carb	1kΩ ±10% 1/10W	24341-280
R55	Carb	2kΩ ±5% 1/10W	24331-287
R56	Carb	12kΩ ±10% 1/10W	24341-312
R57	Carb	2kΩ ±5% 1/10W	24331-287
R58	Carb	12kΩ ±10% 1/10W	24341-312
R59	Carb	4.7kΩ ±10% 1/10W	24341-300
R60	Carb	1kΩ ±10% 1/10W	24341-280
R61	Carb	3.9kΩ ±10% 1/10W	24341-296
R62	Carb	3.9kΩ ±10% 1/10W	24341-296
R63	Carb	3.9kΩ ±10% 1/10W	24341-296
R64	Carb	820Ω ±5% ¼W	24332-678
R65	Carb	1.8kΩ ±5% ¼W	24332-686
R66	Carb	2kΩ ±5% ¼W	24332-687
R67	WW	100Ω ±5% 3W	25125-350
R68	Carb	27Ω ±10% ¼W	24342-031
R69	Carb	1kΩ ±5% 1/10W	24331-280
R70	Carb	470Ω ±5% 1/10W	24331-269
R71	Carb	5.6kΩ ±5% 1/10W	24331-303
R72	Carb	22kΩ ±5% 1/10W	24331-318
R73	Carb	1.5kΩ ±5% 1/10W	24331-284
R74	Carb	390Ω ±5% 1/10W	24331-265
R75	Carb	1kΩ ±5% 1/10W	24331-280
R76	Carb	1kΩ ±5% 1/10W	24331-280
R77	Carb	3.9kΩ ±5% 1/10W	24331-296
R78	Carb	1.5kΩ ±5% ¼W	24332-684
R79	Carb	5.6kΩ ±5% 1/10W	24331-303
R80	Carb	3.3kΩ ±5% 1/10W	24331-294
R81	Carb	560Ω ±5% 1/10W	24331-272
R82	Carb	3.3kΩ ±5% 1/10W	24331-294
R83	Carb	2.2kΩ ±5% 1/10W	24331-288
R84	Carb	2.2kΩ ±5% 1/10W	24331-288
R85	Carb	3.9kΩ ±5% 1/10W	24331-296
R86	Carb	1kΩ ±5% 1/10W	24331-280
R87	Carb	470Ω ±5% 1/10W	24331-269
R88	Carb	3.3kΩ ±5% 1/10W	24331-294
R89	Carb	3.3kΩ ±5% 1/10W	24331-294
R90	Carb	5.6kΩ ±5% 1/10W	24331-303
R91	Carb	2.7kΩ ±5% 1/10W	24331-292
R92	Carb	2.2kΩ ±5% 1/10W	24331-288
R94	Carb	68kΩ ±10% ¼W	24342-131
R95	Carb	100kΩ ±10% 1/10W	24341-335
R96	Carb	10kΩ ±10% 1/10W	24341-310
R97	Carb	100kΩ ±10% 1/10W	24341-335

For symbols and abbreviations see introduction to this section

Circuit reference		Description	M.I. code
R98	Carb	10kΩ ±10% 1/10W	24341-310
R99	Carb	100kΩ ±10% 1/10W	24341-335
R100	Carb	100kΩ ±10% 1/10W	24341-335
R101	Carb	100kΩ ±10% 1/10W	24341-335
R102	Carb	10kΩ ±10% 1/10W	24341-310
R103	Carb	100kΩ ±10% 1/10W	24341-335
R104	Carb	100kΩ ±10% 1/10W	24341-335
R105	Carb	10kΩ ±10% 1/10W	24341-310
R106	Carb	100kΩ ±10% 1/10W	24341-335
R107	Carb	100kΩ ±10% 1/10W	24341-335
R108	Carb	10kΩ ±10% 1/10W	24341-310
R109	Carb	100kΩ ±10% 1/10W	24341-335
R110	Carb	33kΩ ±10% ¼W	24342-122
R115	Carb	560Ω ±5% 1/10W	24331-272
R116	Carb	560Ω ±5% 1/10W	24331-272

TRANSISTORS

VT1	General purpose	MIP 95008
VT2	General purpose	MIP 95008
VT3	General purpose	MIP 95008
VT4	General purpose	MIP 95008
VT5	General purpose	MIP 95008
VT6	General purpose	MIP 95008
VT7	General purpose	MIP 95008
VT8	General purpose	MIP 95008
VT9	General purpose	MIP 95008
VT10	General purpose	MIP 95008
VT11	General purpose	MIP 95008
VT12	General purpose	MIP 95008
VT13	General purpose	MIP 95008
VT14	General purpose	MIP 95008
VT15	General purpose	MIP 95008
VT16	General purpose	MIP 95008
VT17	General purpose	MIP 95008
VT18	General purpose	28433-456
VT19	General purpose	MIP 96501
VT20	General purpose	MIP 96501
VT21	General purpose	MIP 95008
VT22	General purpose	MIP 95008
VT23	General purpose	MIP 95008
VT24	General purpose	MIP 96501
VT25	General purpose	MIP 96501
VT26	General purpose	MIP 95008
VT27	General purpose	MIP 95008
VT28	General purpose	28433-456
VT29	High voltage	MIP 95514
VT30	High voltage	MIP 95514
VT31	High voltage	MIP 95514
VT32	High voltage	MIP 95514
VT33	High voltage	MIP 95514
VT34	High voltage	MIP 95514
VT35	High voltage	MIP 95514
VT36	High voltage	MIP 95514
VT37	High voltage	MIP 95514
VT38	High voltage	MIP 95514

Units Indicator: TM 7446

CAPACITORS

C1	Cer	680pF ±10% 500V	26383-232
C2	Elec	10μF +50% -20% 35V	26414-121

For symbols and abbreviations see introduction to this section

Circuit reference	Description	M.I. code
LAMPS		
ILP1	6V 40mA	23010-034
ILP2	6V 40mA	23010-034
ILP3	6V 40mA	23010-034
ILP4	6V 40mA	23010-034
ILP5	6V 40mA	23010-034
ILP6	6V 40mA	23010-034
ILP7	6V 40mA	23010-034
ILP8	6V 40mA	23010-034
ILP9	6V 40mA	23010-034
ILP10	6V 40mA	23010-034
ILP11	6V 40mA	23010-034
ILP12	6V 40mA	23010-034
ILP13	6V 40mA	23010-034
ILP14	6V 40mA	23010-034
ILP15	6V 40mA	23010-034
ILP16	6V 40mA	23010-034
ILP17	6V 40mA	23010-034
ILP18	6V 40mA	23010-034
ILP19	6V 40mA	23010-034
ILP20	6V 40mA	23010-034
ILP21	6V 40mA	23010-034
ILP22	6V 40mA	23010-034
ILP23	6V 40mA	23010-034

Circuit reference	Description	M.I. code
DIODES		
MR1	General purpose	MIP 91003
MR2	General purpose	MIP 91003
MR3	High G	MIP 91004
MR4	High G	MIP 91004
MR5	High G	MIP 91004
MR6	High G	MIP 91004
MR7	High G	MIP 91004
MR8	High G	MIP 91004
MR9	High G	MIP 91004
MR10	High G	MIP 91004
MR11	High G	MIP 91004
MR12	General purpose	MIP 91003
MR13	High G	MIP 91004
RESISTORS		
R1	WW 330Ω ±5% 3½W	25125-628
R2	Carb 1.8kΩ ±5% 1/10W	24331-286
R3	Carb 1.8kΩ ±5% 1/10W	24331-286
R4	Carb 1.8kΩ ±5% 1/10W	24331-286
R5	Carb 27kΩ ±5% 1/10W	24331-320
R6	Carb 180Ω ±5% ¼W	24332-656
R7	Carb 8.2kΩ ±5% 1/10W	24331-308
R8	Carb 2.7kΩ ±5% 1/10W	24331-292
R9	Carb 3.6kΩ ±5% 1/10W	24331-295
R10	Carb 1kΩ ±5% 1/10W	24331-280
R11	Carb 1kΩ ±5% 1/10W	24331-280
R12	Carb 10kΩ ±5% 1/10W	24331-310
R13	Carb 4.7kΩ ±5% 1/10W	24331-300
R14	Carb 200Ω ±5% ¼W	24332-657
R15	Carb 10Ω ±10% 1/10W	24341-220
R16	Carb 47Ω ±5% ¼W	24332-637
R17	Carb 10Ω ±10% 1/10W	24341-220
TRANSISTORS		
VT1	General purpose	MIP 95008
VT2	General purpose	MIP 96501
VT3	General purpose	MIP 95008
VT4	General purpose	MIP 95008

For symbols and abbreviations see introduction to this section

Section 7

Circuit diagrams

Circuit notes

1. COMPONENT VALUES

Resistors : No suffix = ohms. k = kilohms. M = megohms.
Capacitors : No suffix = microfarads. p = picofarads.
* value selected during test; nominal value shown.

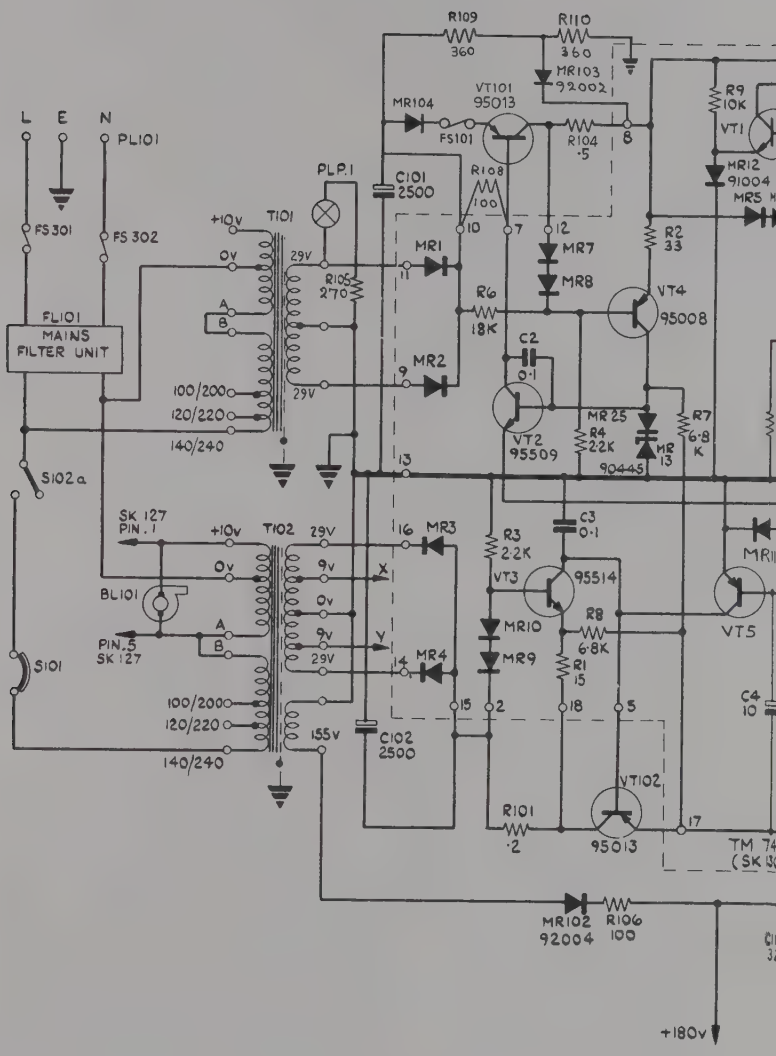
2. SYMBOLS

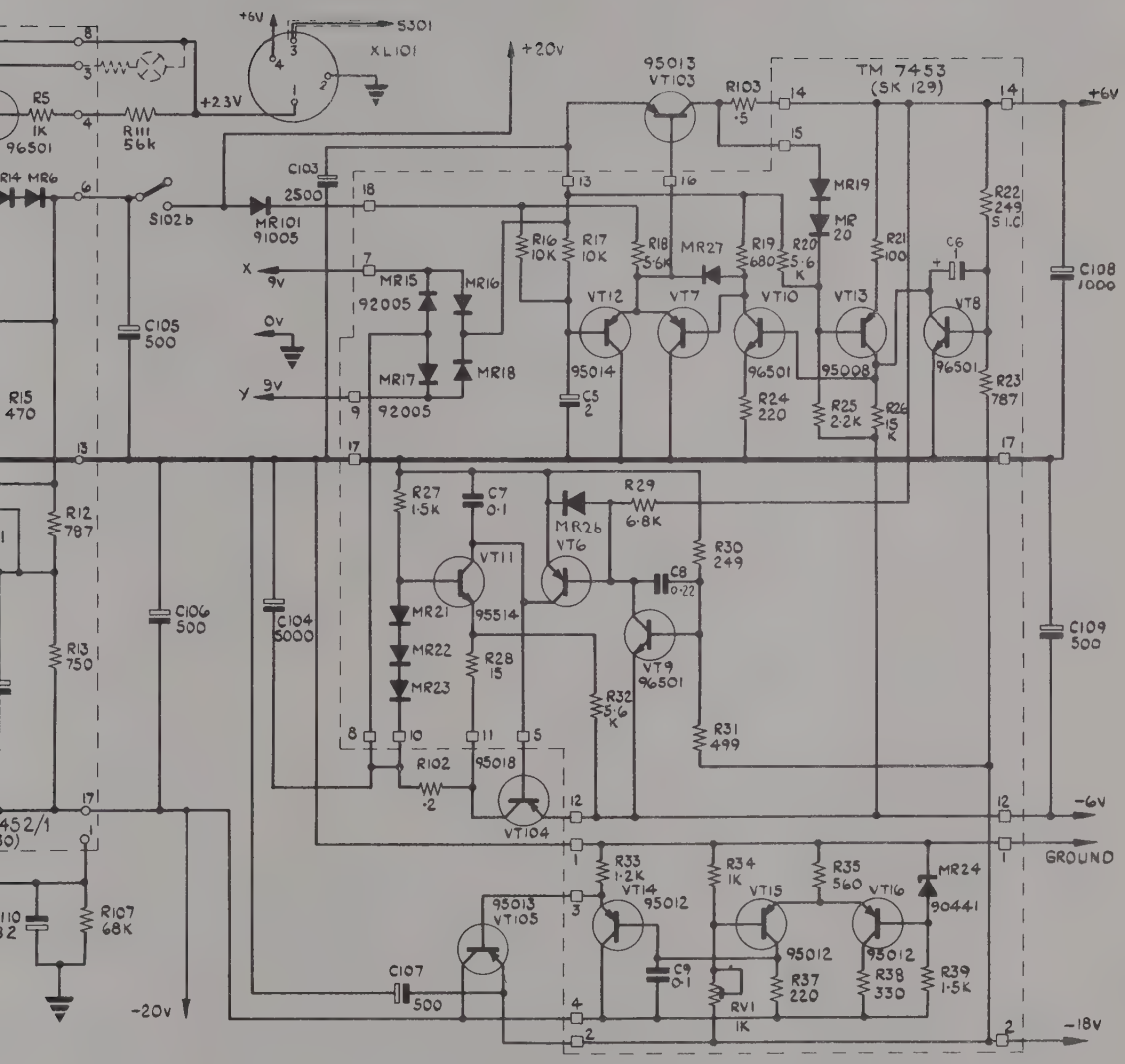
+► arrow indicates clockwise rotation of knob.

○ indicates pins on socket to front of counter.

□ indicates pins on socket to rear of counter.

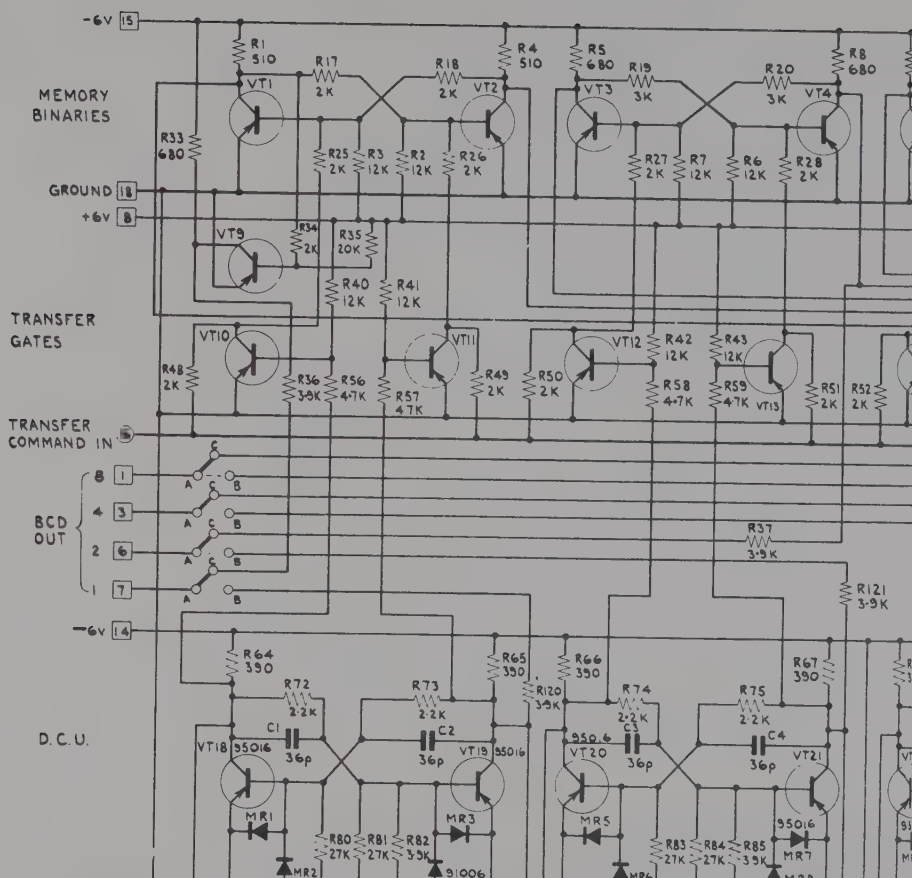
Numbers adjacent to diodes and transistors refer to MIP specification.


L
E
N
PL101
FS301
FS302
FL101
MAINS
FILTER UNIT
S102a
S101
BL101
PIN.5
SK127
SK 127
PIN. 1
PLP.1
T101
T102
+10v
0v
A
B
100/200
120/220
140/240
29V
9v
155v
R105
270
C101
2500
C102
2500
R109
360
R110
360
MR103
92002
MR104
FS101
VT101
95013
R104
·5
R108
100
MR1
MR2
MR7
MR8
R6
1·8K
C2
0·1
VT2
95509
VT4
95008
R2
33
R9
10K
VT1
MR12
91004
MR5
MR25
R4
2·2K
MR
13
90445
R7
6·8
K
C3
0·1
R3
2·2K
VT3
95514
MR10
MR9
R8
6·8K
R1
15
MR3
MR4
VT5
C4
10
VT102
R101
·2
95013
MR102
92004
R106
100
TM 74
(SK 13
+180v
All diod



odes are to MIP 92003 unless shown otherwise

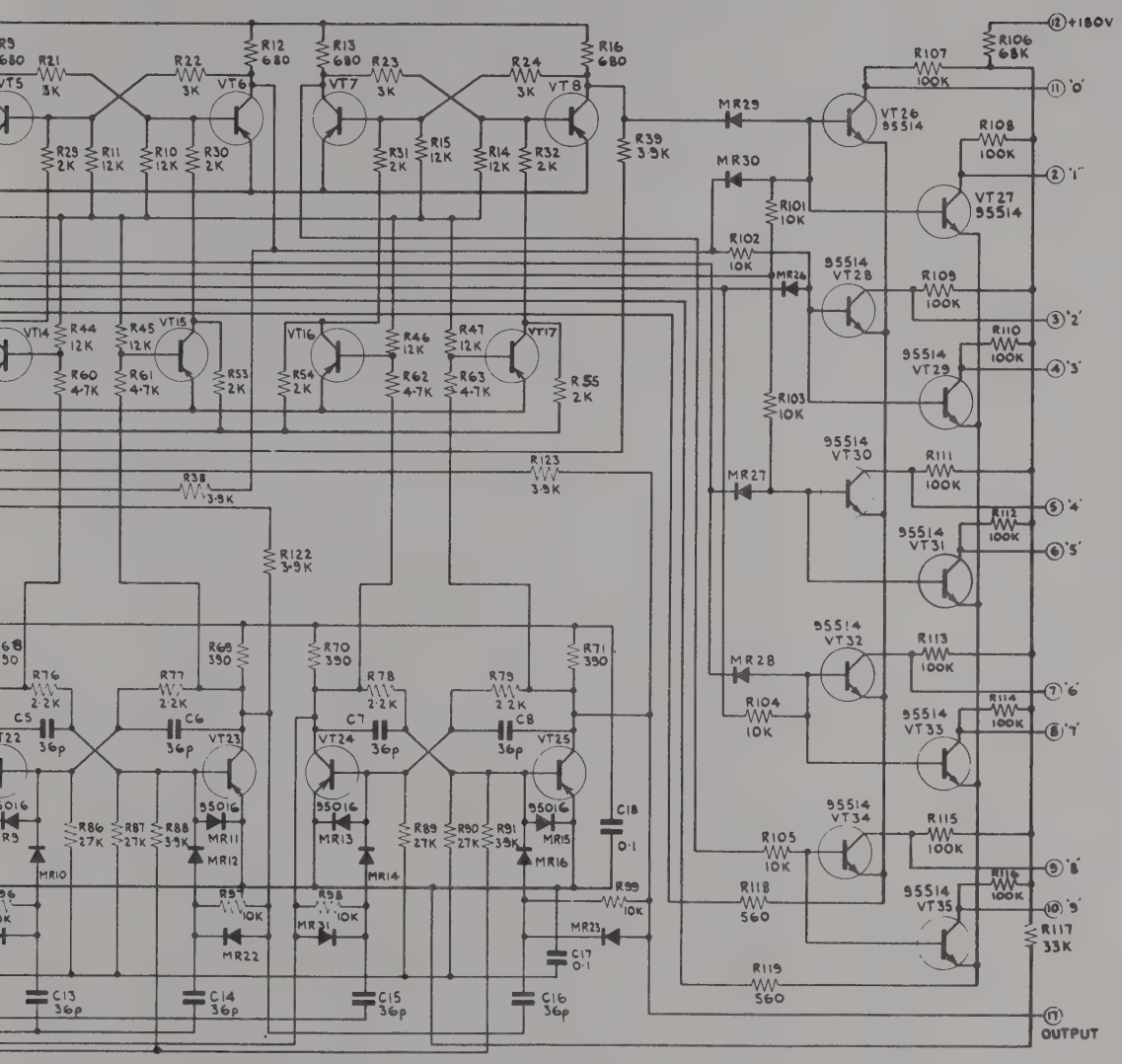
Fig. 7.1 Power Supply TM 7452/1, TM 7453, TM 7614/1



All diodes are to

All transistors ar

If output from de
change links fro

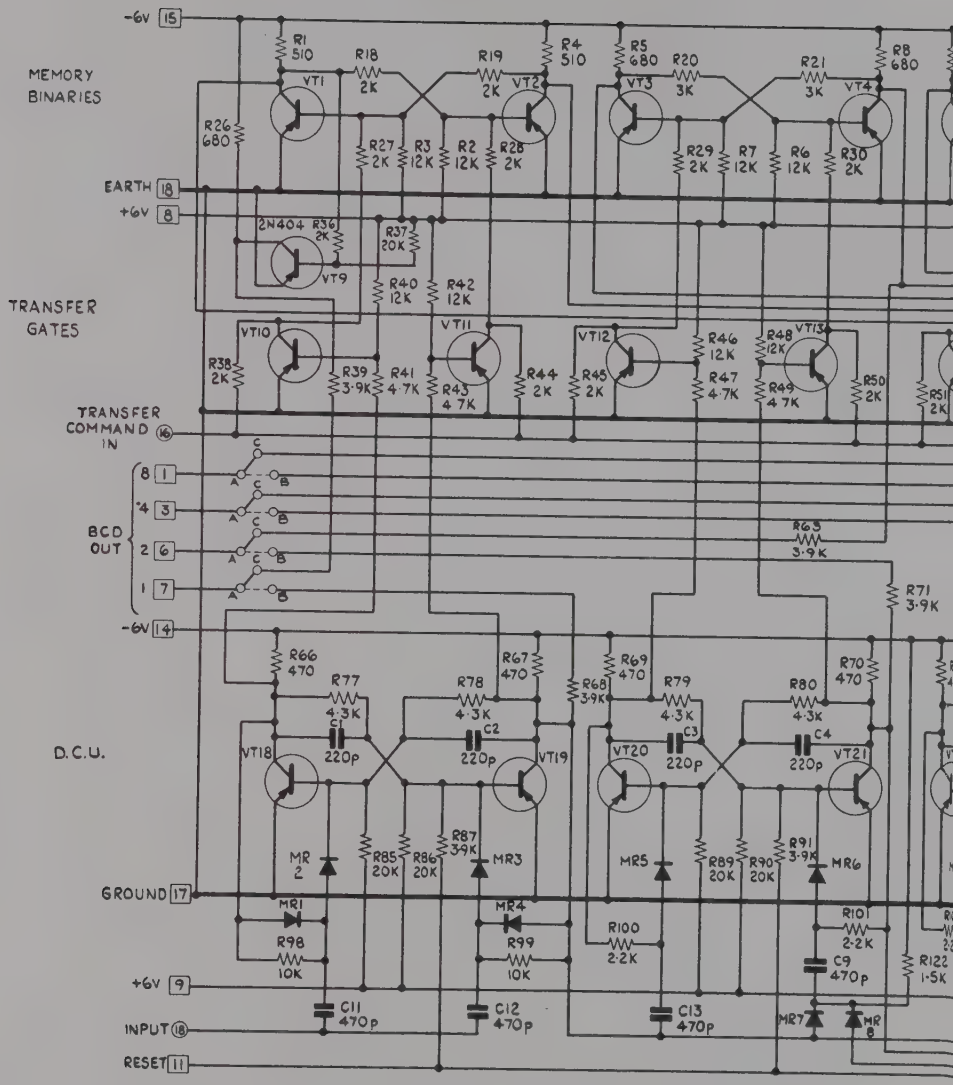


MIP 91003 unless shown otherwise

re to MIP 95008 unless shown otherwise

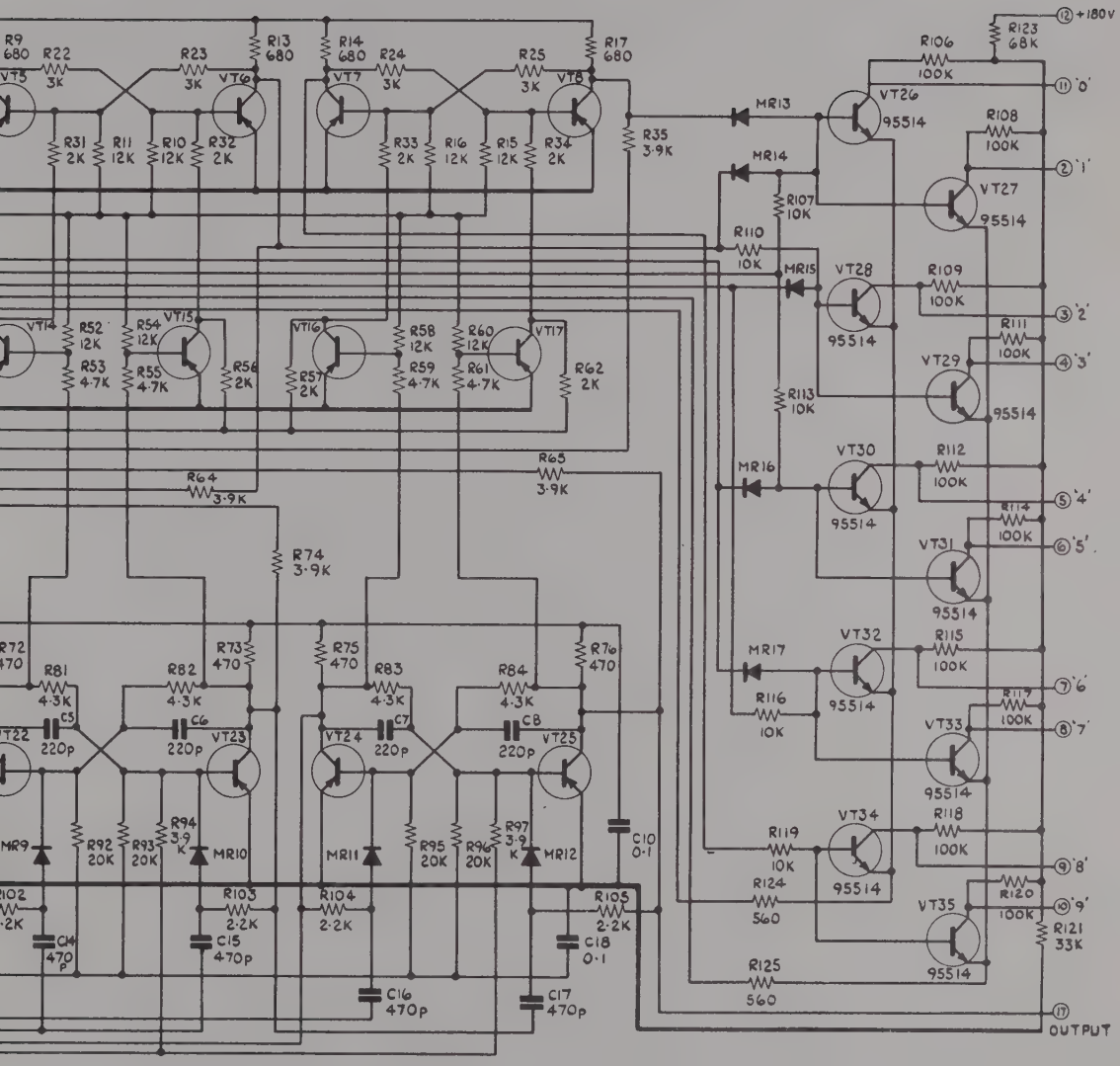
ecade is required (not output from memory)
m A–C to A–B

Fig. 7.2 10 Mc/s D.C.U. with Memory and Readout TM 7448



All diodes are to M

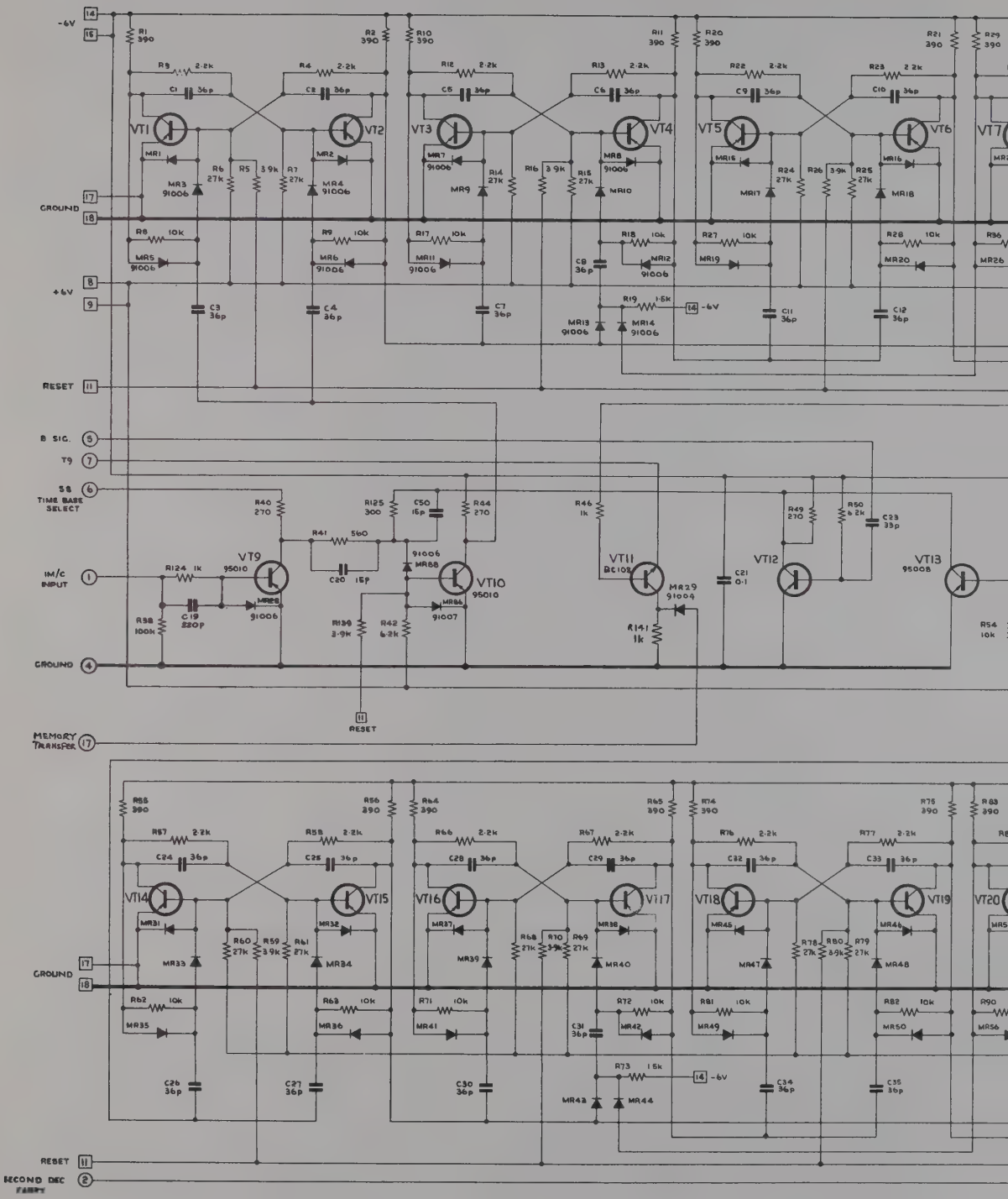
All transistors are

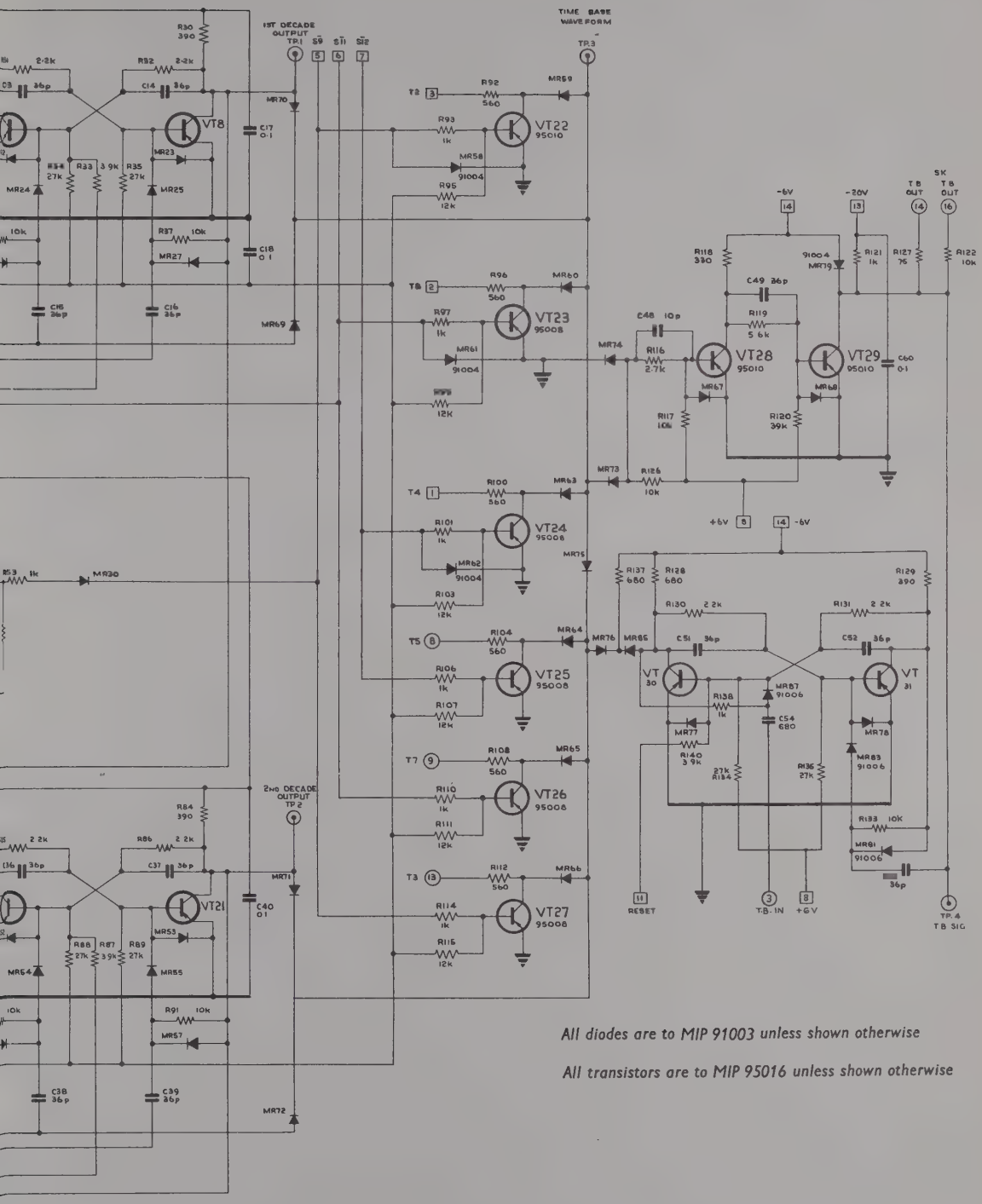


MIP 91003 unless shown otherwise

to MIP 95008 unless shown otherwise

Fig. 7.3 250 kc/s D.C.U. with Memory and Readout TM 7449

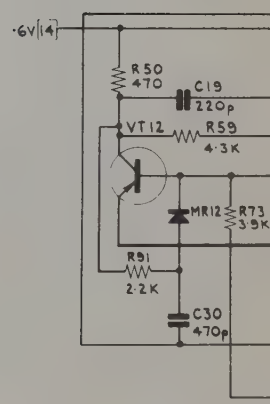

-6V
GROUND
+6V
RESET
B SIG.
T9
SS
TIME BASE SELECT
IM/C INPUT
GROUND
MEMORY TRANSFER
GROUND
RESET
SECOND DEC FAST
VT1
VT2
VT3
VT4
VT5
VT6
VT7
VT9
VT10
VT11
VT12
VT13
VT14
VT15
VT16
VT17
VT18
VT19
VT20

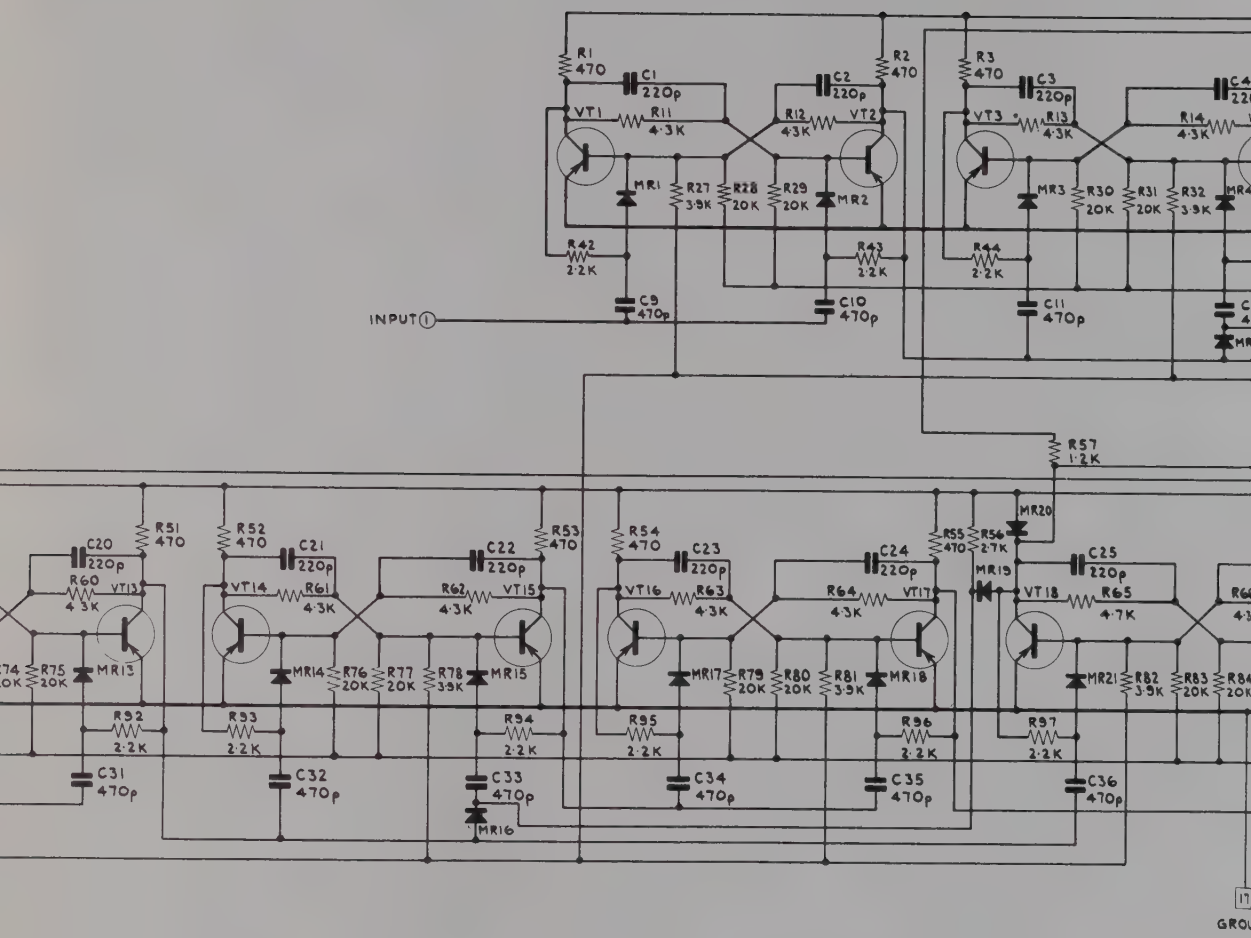


All diodes are to MIP 91003 unless shown otherwise

All transistors are to MIP 95016 unless shown otherwise

Fig. 7.4 10 Mc/s Dual Decade TM 7450/1


·6V[14]
R50
470
C19
220p
VT12
R59
4·3K
MR12
R73
3·9K
R91
2·2K
C30
470p



All diodes are to MIP 91003 unless shown otherwise

All transistors are to MIP 95008 unless shown otherwi

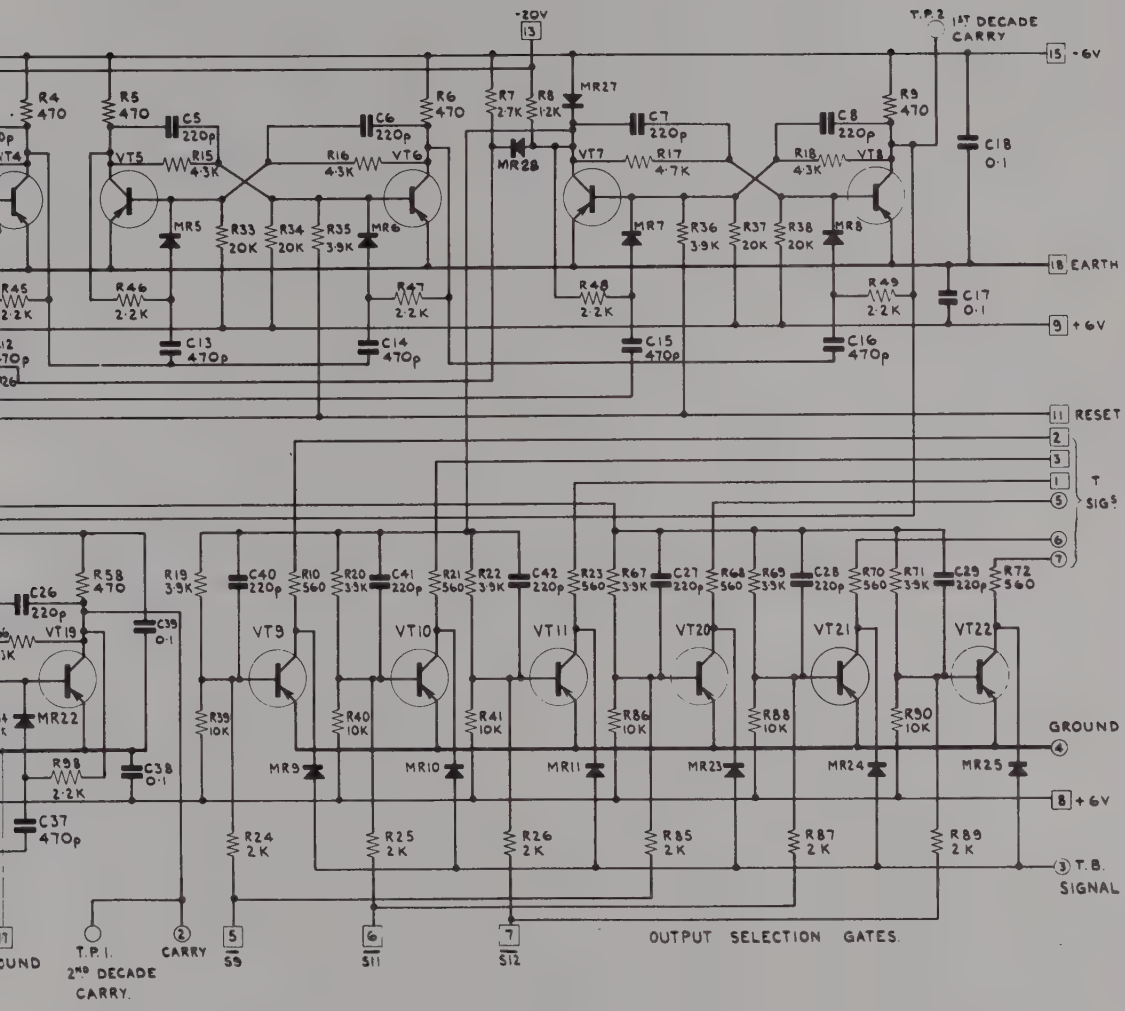
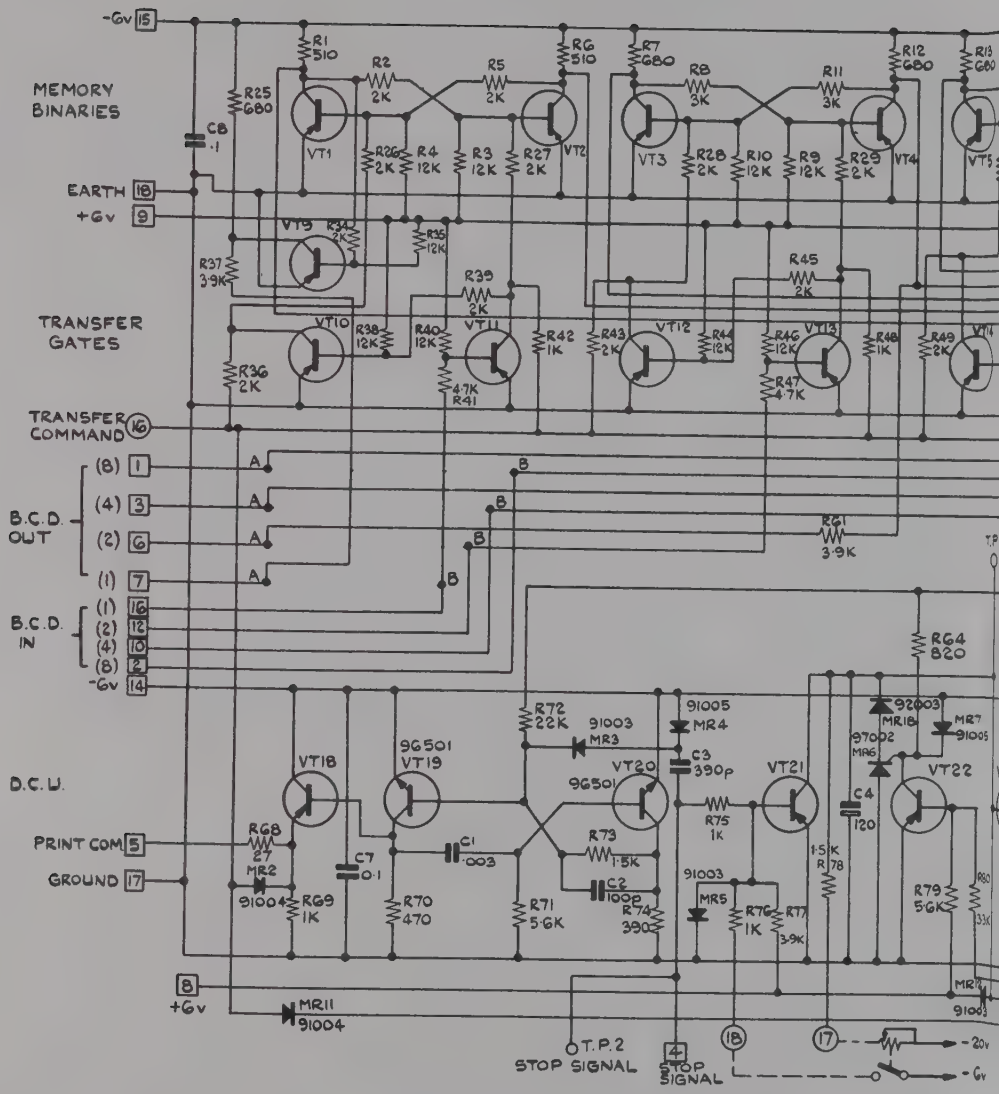
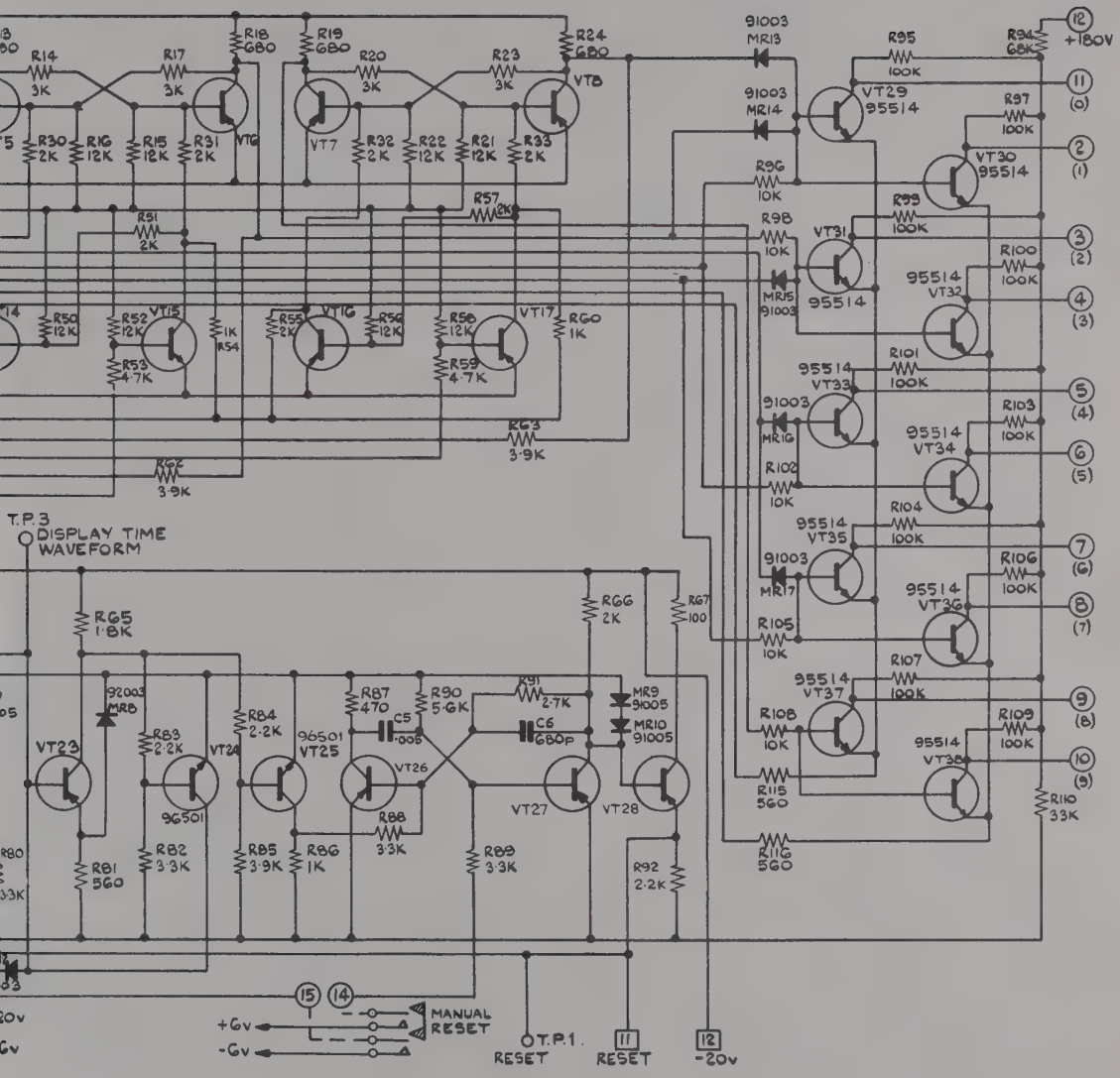


Fig. 7.5 250 kc/s Dual Decade TM 7451



All transistors are to M

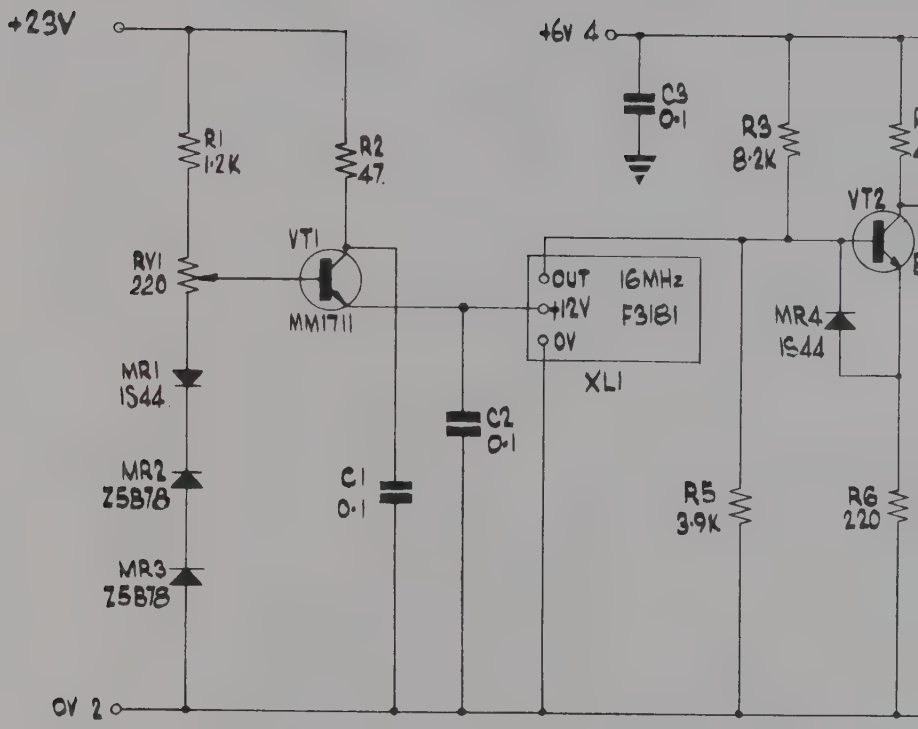
If output from decade is
remove R37, R61, R62 a



e to MIP 95008 unless shown otherwise

ade is required (not output from memory)
R62 and R63 and replace between A and B

Fig. 7.6 Display Control, Reset and Memory for first D.C.U. TM 7447


+23V
+6V 4
C3
0·1
R3
8·2K
R1
1·2K
R2
47
VT1
VT2
RV1
220
MM1711
OUT
+12V
0V
16MHz
F3181
XL1
MR4
1S44
MR1
1S44
C2
0·1
MR2
Z5B78
C1
0·1
R5
3·9K
R6
220
MR3
Z5B78
0V 2

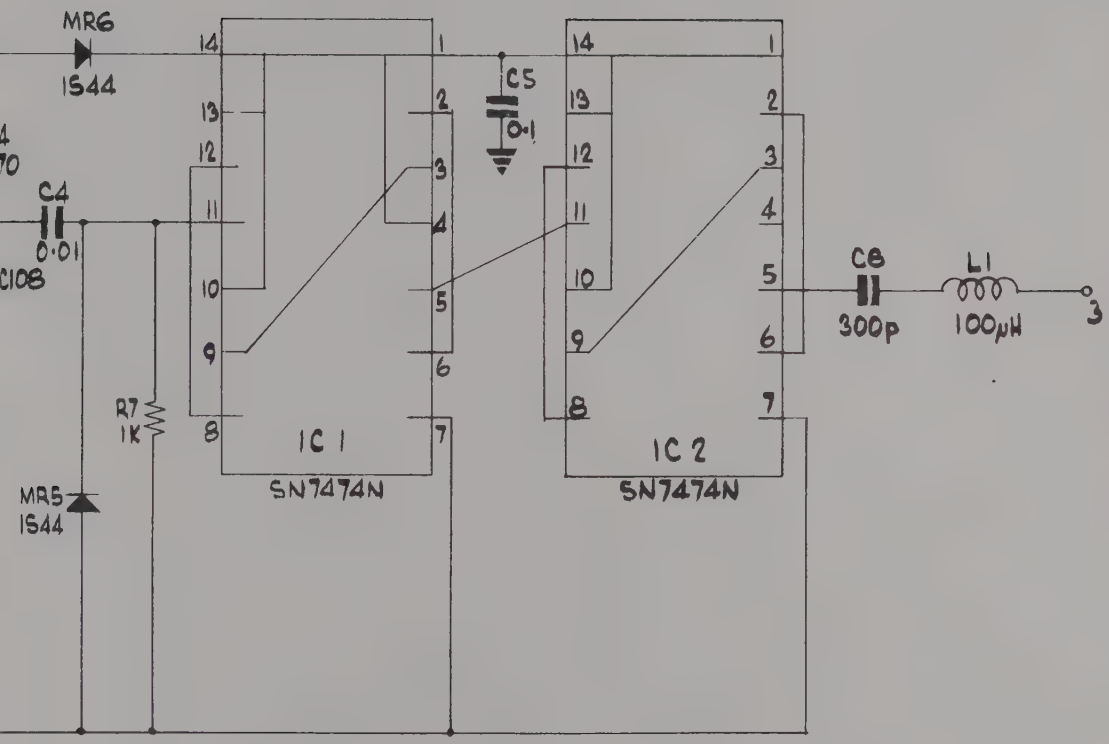
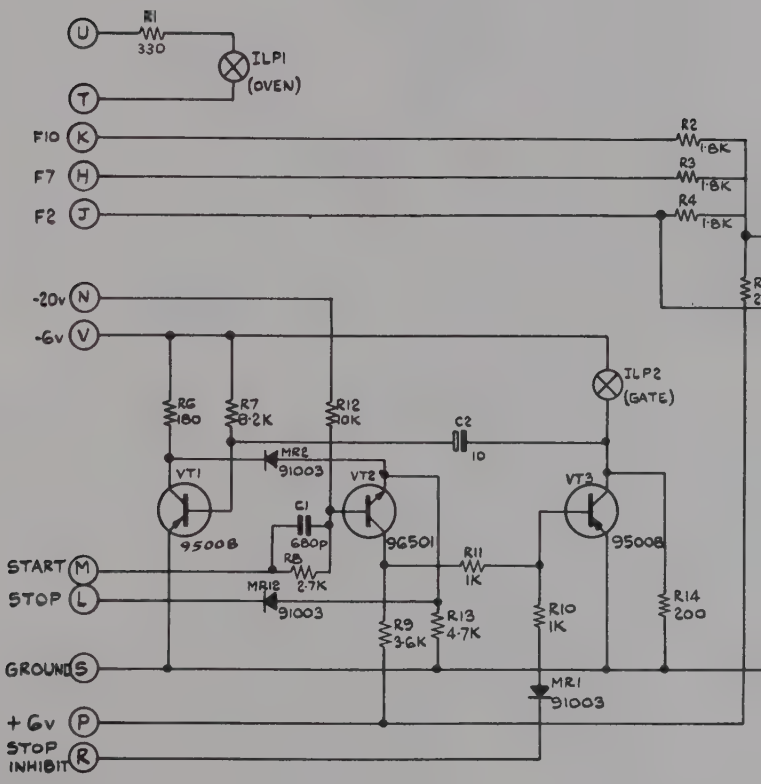


Fig. 7.7 Oscillator and Divider


U
R1
330
ILP1
(OVEN)
T
F10 K
F7 H
F2 J
R2
1·8K
R3
1·8K
R4
1·8K
-20v N
-6v V
R6
180
R7
8·2K
R12
10K
C2
10
ILP2
(GATE)
MR2
91003
VT1
VT2
VT3
C1
680P
9500B
9G501
9500B
START M
STOP L
R8
2·7K
MR12
91003
R11
1K
R10
1K
R14
200
R9
3·6K
R13
4·7K
GROUND S
MR1
91003
+6v P
STOP
INHIBIT R

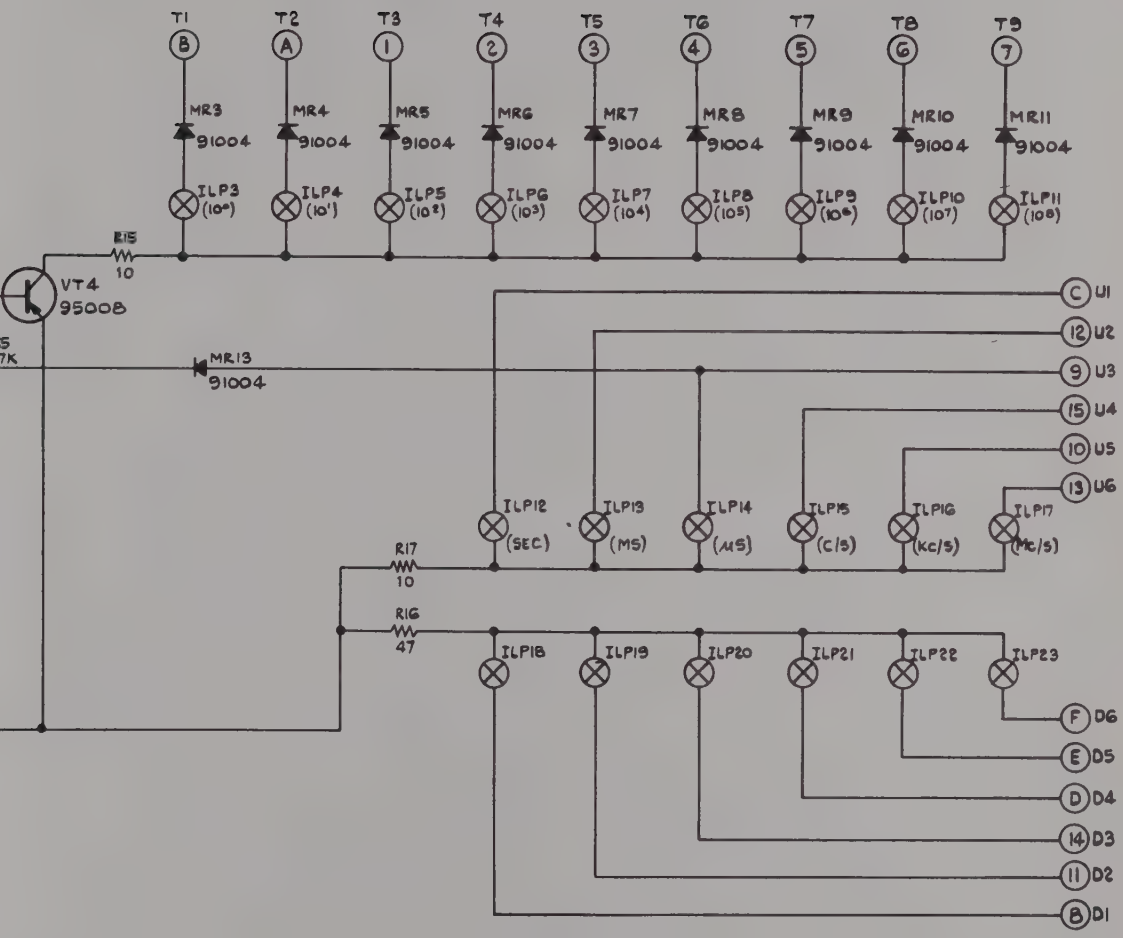
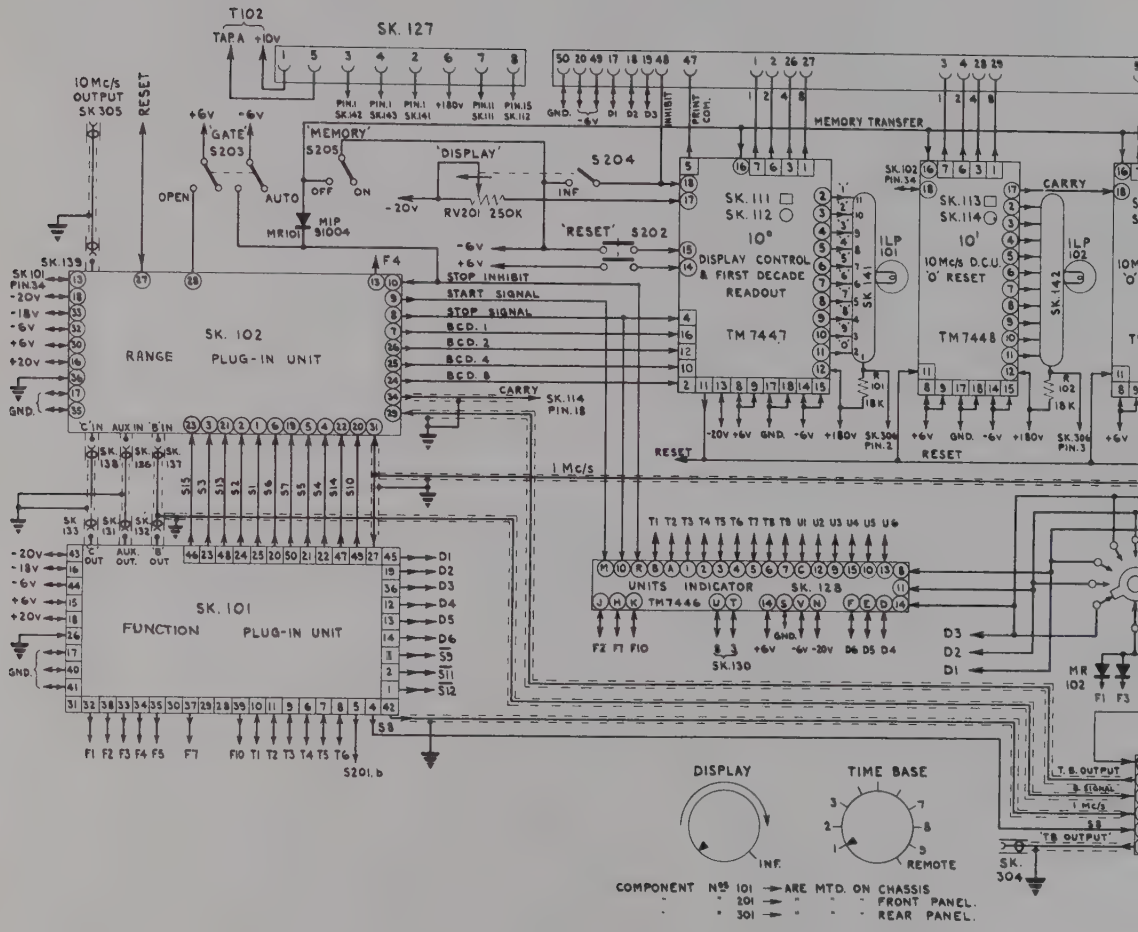


Fig. 7.8 Units Indicator TM 7446


T102
TAP A +10v
SK. 127
10Mc/s OUTPUT SK 305
RESET
+6v -6v
'GATE' S203
OPEN
AUTO
'MEMORY' S205
OFF ON
MIP 91004 MR101
-20v
RV201 250K
'DISPLAY'
S204
INF
'RESET' S202
-6v
+6v
STOP INHIBIT
START SIGNAL
STOP SIGNAL
BCD. 1
BCD. 2
BCD. 4
BCD. 8
CARRY
SK.114 PIN.18
SK 139
SK 101 PIN.34
-20v
-18v
-6v
+6v
+20v
GND.
SK. 102
RANGE PLUG-IN UNIT
'C' IN AUX IN 'B' IN
SK. 138
SK. 136
SK. 137
S15 S3 S13 S2 S1 S6 S7 S5 S14 S10
SK 133
SK 131
SK 132
1 Mc/s
SK. 101
FUNCTION PLUG-IN UNIT
'C' OUT
AUX. OUT.
'B' OUT
D1 D2 D3 D4 D5 D6 S5 S11 S12
S9
F1 F2 F3 F4 F5 F7 F10 T1 T2 T3 T4 T5 T6
S201. b
SK. 111 □
SK. 112 ○
10°
DISPLAY CONTROL & FIRST DECADE READOUT
TM 7447
ILP 101
SK 141
R 101 18K
SK.306 PIN.2
RESET
-20v +6v GND. -6v +180v
10'
10Mc/s D.C.U. 'O' RESET
TM 7448
SK.113 □
SK.114 ○
SK.102 PIN.34
CARRY
SK 142
ILP 102
R 102 18K
SK.306 PIN.3
+6v GND. -6v +180v
MEMORY TRANSFER
PRINT COM.
INHIBIT
GND. -6v D1 D2 D3
T1 T2 T3 T4 T5 T6 T7 T8 T9 U1 U2 U3 U4 U5 U6
UNITS INDICATOR SK. 128
TM 7446
F2 F1 F10
S_3 SK.130
+6v -6v -20v
D6 D5 D4
D3 D2 D1
MR 102
F1 F3
DISPLAY
INF.
TIME BASE
REMOTE
T.B. OUTPUT
B SIGNAL
1 Mc/s
S8
'TB OUTPUT'
SK. 304
COMPONENT Nos 101 → ARE MTD. ON CHASSIS
" 201 → " " FRONT PANEL.
" 301 → " " REAR PANEL.

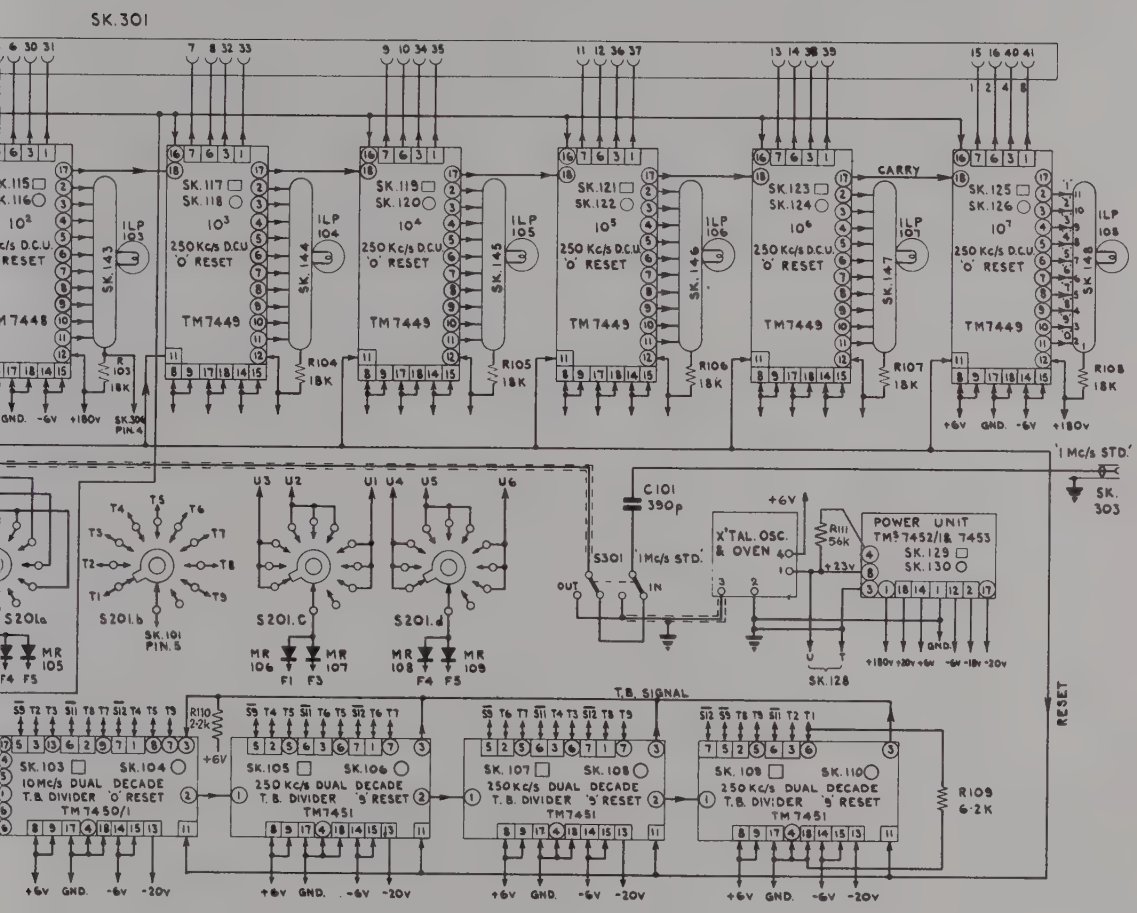
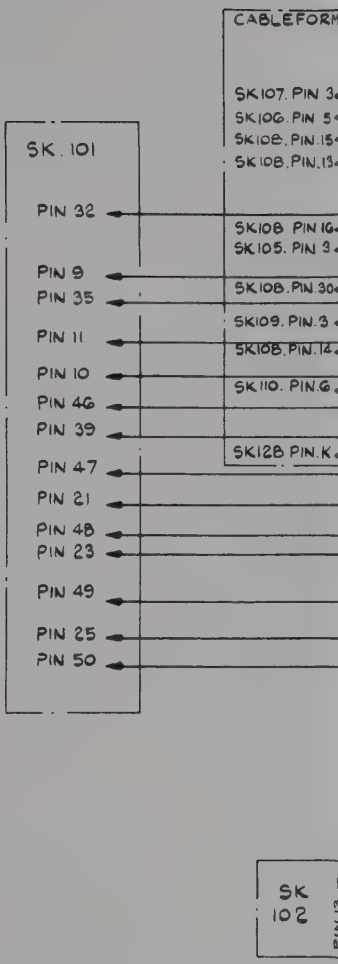


Fig. 7.9 Interconnecting diagram


CABLEFORM
SK.107. PIN 3
SK.106. PIN 5
SK.108. PIN.15
SK.108. PIN.13
SK. 101
PIN 32
SK108 PIN 16
SK.105. PIN 3
PIN 9
PIN 35
SK.108. PIN 30
SK109. PIN.3
PIN 11
SK108. PIN.14
PIN 10
SK.110. PIN.6
PIN 46
PIN 39
SK128 PIN.K
PIN 47
PIN 21
PIN 48
PIN 23
PIN 49
PIN 25
PIN 50
SK
102

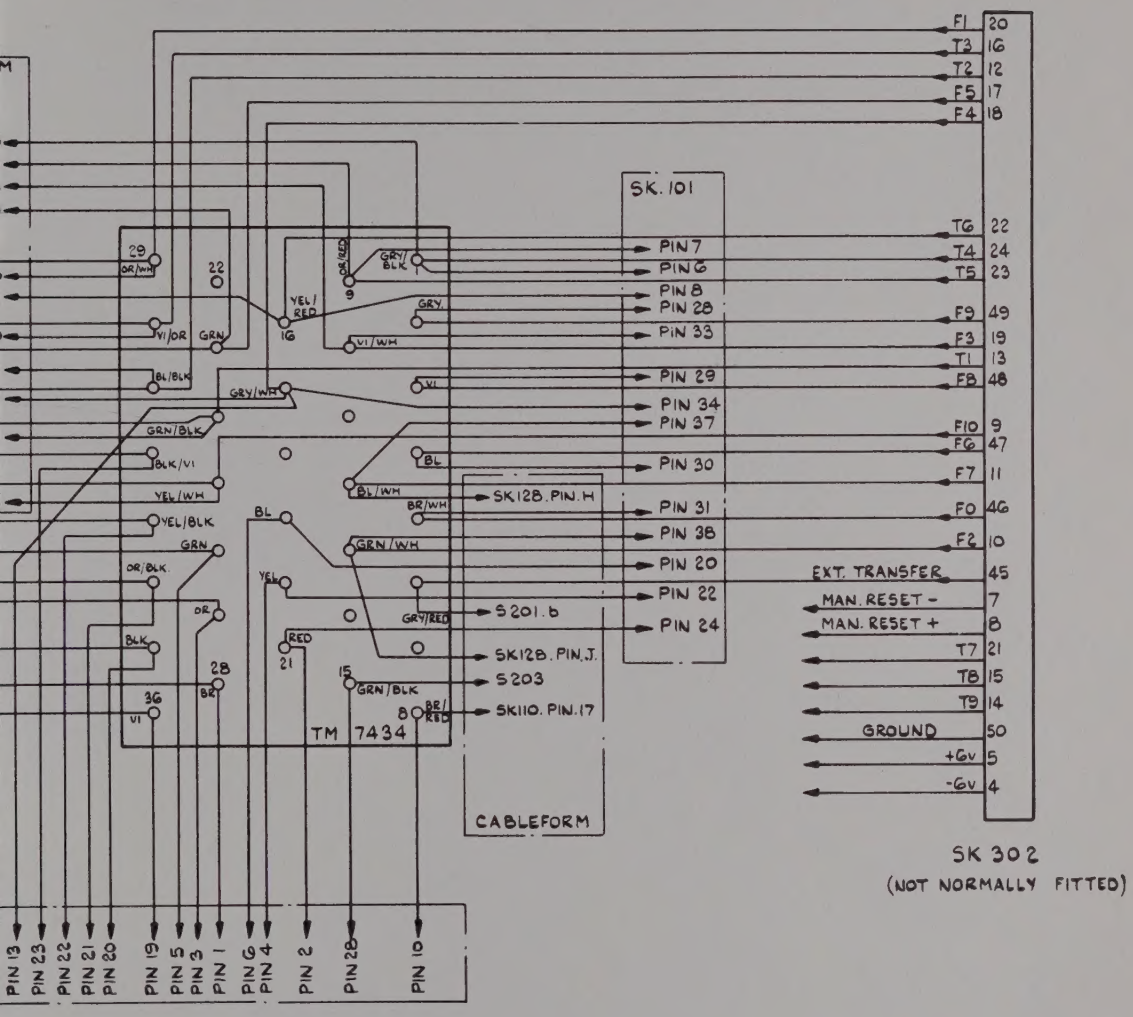


Fig. 7.10 Wiring diagram

TF 2401A

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